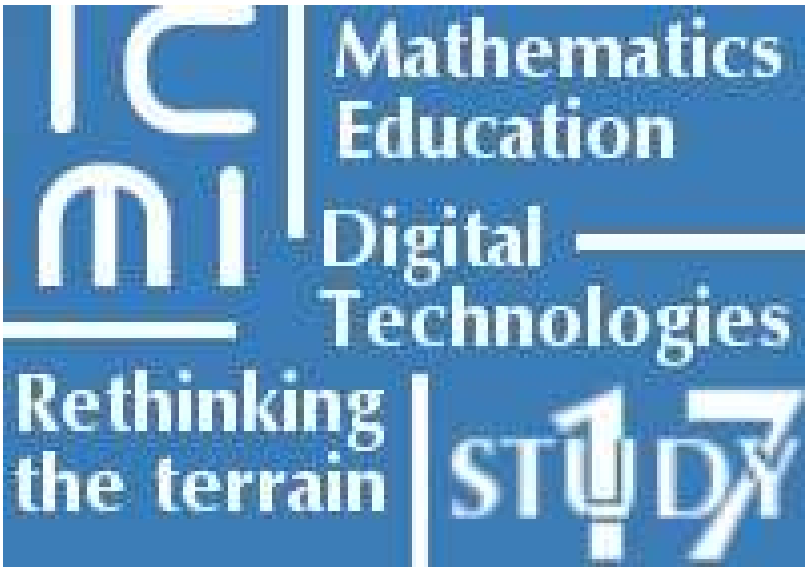
Seventeenth ICMI Study

Technology Revisited



Study conference

Hanoi University of Technology

December 3-8 2006

Conference Booklet

Foreword

Celia Hoyles and Jean-baptiste Lagrange
Co-chairs of the study for the International Program Committee.

The series of ICMI Studies was launched in the mid-80s in order to investigate themes (key issues or topic areas) of particular significance to the theory or practice of contemporary mathematics education. The general aim of a Study is to provide an up-to-date presentation and analysis of the state-of-the-art concerning a theme, whether by identifying and describing current research contributions and their findings, or by identifying and discussing issues involving genuine controversies or dilemmas and the different positions towards them held by various mathematics educators.

The typical scheme of an ICMI Study

Once a theme has been decided upon by the Executive Committee of ICMI, the initial step is the appointment by the EC of an International Program Committee which on behalf of ICMI is responsible for conducting the Study. The first task of the IPC is the production of a *Discussion Document* to set the stage for the Study by identifying, presenting and discussing in a preliminary manner a general *problématique*, a number of key issues and sub-themes related to the theme of the Study. Readers are invited to react in writing to the Discussion Document by submitting ideas, proposals, abstracts or drafts of papers and suchlike for consideration by the IPC.

On the basis of the reactions received and of the deliberations within the IPC itself, the IPC invites a limited number (50-100) of individuals to participate in an invited *Study Conference* which will form a working forum for investigating the theme of the Study.

Finally, a *Study Volume*, resulting from the contributions presented to the Study Conference as well as from the discussions that took place there, is published under the general editorship of the ICMI Study Series editors, the President and Secretary of ICMI. The nature of such a volume is *not* that of conference proceedings.

Technology revisited

At its annual meeting in July 2002, the ICMI Executive Committee decided, , the launching of a new ICMI Study whose theme was "Technology revisited" because the very first ICMI Study, held in Strasbourg in 1985, was on the influence of computers and informatics on mathematics and its teaching.

The International Program Committee (IPC) first met in April 2004 to draft the Discussion Document. It was decided that cultural diversity and how this diversity impinges on the use of digital technologies in mathematics teaching and learning particularly in developing countries would be one major focus for ICMI Study 17. The Discussion Document was then disseminated through the mathematics education community About 90 papers were submitted from all the parts of the world indicating that this major focus was well received by the community.

The submitted papers were read by three or four members of the IPC. Invitations were then issued, taking into account paper submissions, areas of interest and expertise, the goals and objectives of the conference, and geographic representation.

During the conference, the invited participants will contribute to working groups. Each working group will address the issues raised in the Discussion Document by considering more specifically a theme. Each theme is introduced below. The deliberation of the working groups will form the basis of an edited book, which will continue the ICMI study series.

Finally, we wish to offer our thanks to the persons who are assisting us to make this study a success:

- the Minister of Education of Vietnam and the Rector of Hanoi University of Technology for offering to organize the conference in Hanoi,
- the members of the local committee,
- our sponsors

  Autograph

  Texas Instruments

  Unesco,
- and other companies or institution supporting the conference: Cabrilog, Keypress curriculum press, Metah (IMAG)

Contents

Organizers

- Hanoi University of Technology (HUT)
- International Commision on Mathematical Instruction (ICMI)
- Institute of Mathematics, Vietnamese Academy of Science and Technology
- Chu Van An High School

Location

The conference takes place at the Hanoi University of Technology

№ 1, Dai Co Viet Street., Hanoi, Vietnam.

Main Sponsors

- ✓ Hanoi University of Technology (HUT)
- ✓ International Committee on Mathematical Instruction (ICMI)
- ✓ United Nations Educational Scientific and Cultural Orgnization (UNESCO)
- ✓ Chu Van An High School
- ✓ Autograph
- ✓ Texas Instruments (TI)

Other companies supporting the conference

- ✓ Key Curriculum Press
- ✓ CabriLog
- ✓ Institut d'Informatique et Mathématiques Appliquées de Grenoble (IMAG)

About ICMI

The International Commission on Mathematical Instruction, ICMI, was first established at the International Congress of Mathematicians held in Rome in 1908, on the suggestion of the American mathematician and historian of mathematics David Eugene Smith. The first President of ICMI was Felix Klein. From the very beginning, the international journal L'Enseignement Mathématique was adopted as the official organ of ICMI - which it is still today. ICMI also publishes, a Bulletin twice a year. Starting with Bulletin No. 39, December 1995, the ICMI Bulletin is accessible on the internet

http://www.mathunion.org/ICMI/bulletin.

Members of the International Programme Committee

Prof. Celia Hoyles, Institute of Education, University of London, UK

Prof. Jean-Baptiste Lagrange, IUFM de Reims, France

Prof. Douglas Clements, Department of Learning and Instruction, University at Buffalo, US (up to August 2005)

Dr. Paul Drijvers, Freudenthal Institute, The Netherlands

Dr. Lulu Healy, Centre of Science & Technology, Pontificia Universidade Católica (PUC), Brazil

Prof. Cyril Julie, School of Science and Mathematics Education, University of the Western Cape, South Africa

Prof. Maria Alessandra Mariotti, Department of Science, Mathematics and Informatics, Università di Siena, Italy

Prof. John Olive, Department of Mathematics and Science Education, The University of Georgia, US (after August 2005)

Dr. Ana Isabel Sacristan, Department of Mathematics Education, Cinvestav, Mexico

Dr. Evgenia Sendova, Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Bulgaria

Dr. Nathalie Sinclair, Department of Mathematics, Michigan State University, US

Prof. Le Hung Son, Faculty of Applied Mathematics, Hanoi University of Technology, Vietnam

Dr. Colleen Vale, School of Education, Victoria University of Technology, Australia

Prof. Bernard R. Hodgson, Département de mathématiques et de statistique, Université Laval, Canada (*ex officio*, Secretary-General of ICMI)

Members of the Local Committee

Prof.Dr. Hoang Ba Chu, Rector of Hanoi University of Technology (HUT)

(Chairman)

Prof.Dr. Tran van Nhung, Deputy Minister For Training and Education

Vietnam

Ass. Prof. Nguyen Canh Luong, Vice Rector of HUT

Ass.Prof. Ha Duyen Tu, Vice Rector of HUT

Prof.Dr.Sc. Ha Huy Khoai, Director of Institute of Mathematics, Vienam Academy of Science and Technology

Prof.Dr.Sc. Nguyen Van Mau, Rector of Hanoi University of Sciences.

Magist.Nguyen Huu Do, Deputy Director of Department for Education Hanoi

Prof. Dr. Nguyen Dinh Tri, Former President of Vietnam Mathematical Society

Prof.Dr.Sc. Le Hung Son, HUT,Vice President of Hanoi Mathematical Society.

Dr. Hoang Xuan Lan, Head of Department for International Relations, HUT

Dr.Dinh Sy Dai, Director of High School Chu Van An, Hanoi

Ass. Prof. Tong Dinh Quy, Dean of Faculty of Applied Mathematics and Informatics, HUT

Study Programme

Sunday Dec 3	***Monday Dec 4***	***Tuesday Dec 5***	***Wednesday Dec 6***	***Thursday Dec 7***	***Friday Dec 8***
	9.00-10.00 Opening ceremony	9.00-10.45 Sponsored workshops	9.00-10.45 Plenary Panel Mathematical practices	9.00-10.45 Plenary Panel Regional	9- 10.00 2 Plenary reports Presentations from Working Groups
	10.00-11.15 Keynote Papert				
	11.15- 11.30 Coffee break	10.45.-11.15 Coffee break	10.45-11.15 Coffee break	10.45-11.15 Coffee break	10- 10.30 Coffee break
Arrival and registration	11.30-12.30 Working Groups Study Session 1	11.15- 12.30 Paper presentations 4 parallel sessions x 3 papers	11.15- 12.30 Working Groups Study Session 4	11.15- 12.30 Working Groups Study Session 5	10.30 – 11.45 Keynote Artigue
					11.45-12.15 ICMI & Closing Ceremony
	Lunch	Lunch	Lunch	Lunch	Lunch
	14:00- 15:45 Working Groups Study Session 2	14:00- 15:45 Working Groups Study Session 3	Excursion	14:00- 16.00 Working Groups Study Session 6	School visit
	15:45- 16:15 Tea break	15:45- 16:15 Tea break		16.0- 16.30 Tea break	
	16:15-18.00 Paper presentations 4 parallel sessions x 4 papers	16:15-18:15 Plenary Panel Connectivity Chair Hoyles		16.30- 18.00 3 Plenary reports Presentations from Working Groups	
18.00 Welcome reception	18.15 Poster and project presentations	18.15 Project presentations		18.30 Banquet Cultural evening	
	20.00 Dinner	20.00 Dinner	20.00 Dinner		

Rooms List

Activities	Rooms	Location
Ceremony, Reception, Plenary Panel, Keynote	Meeting Hall	C2 building
Paper Presentation	702, 704, 721, 722	Library Ta Quang Buu building
Project Presentation	702, 704, 722	Library Ta Quang Buu building
Video Conference	702	Library Ta Quang Buu building
Working Group	501, 502, 507, 508, 721	Library Ta Quang Buu building
Poster Showroom	2nd Floor Lobby	Library Ta Quang Buu building
IPC Meeting	502	Library Ta Quang Buu building
Secretariat	503	Library Ta Quang Buu building
Coffee Break	7th Floor Lobby	Library Ta Quang Buu building
	Meeting Hall	C2 building
Lunch, Dinner	10th Floor	Library Ta Quang Buu building
Computer Room 1	302	D6 building
Computer Room 2	504	D3 building
Computer Room 3	302	D5 building
Computer Room 4, 5	309, 409	HighTech building

Programme highlights

Sunday, december 03, 2006

Morning: Arrival and Registration

18^{00} pm: Welcome Reception

19^{30} pm: Dinner

Monday, December 04, 2006

9^{00} am-10^{00} am: Opening ceremony

10^{00} am-11^{15} am: Keynote *Seymour Papert*

11^{15} am-11^{30} am: Coffee Break

11^{30} am-12^{30} pm: Working Groups, Study session 1

12^{30} pm-14^{00} pm: Lunch

14^{00} pm-15^{45} pm: Working Groups, Study session 2

15^{45} pm-16^{15} pm: Tea Break

16^{15} pm-18^{15}am: Paper presentations

Session I Room 704	**Session II** Room 721	**Session III** Room 722	**Session IV** Room 702	**Time**
Ana Sacristan	Chow Ming Kong	Allen Leung	Alan Maloney	16.15
Colleen Vale	Chronis Kynigos	Arthur Lee	Ferdinando Arzarello	16.40
Jim Ridgway	Colette Laborde	Hee-Chan Lew	Maria Mariotti Fabrice Vandebrouk	17.05
John Olive	Jaap Den Hertog		Keith Jones	17.30

18^{15} pm-19:^{45} pm: Posters presentation
2nd Floor Lobby LibraryTa Quang Buu building

Anne Berit Fuglestad, Mara Alagic,Mili Das,Valentina Dagiene, Zsolt Lavicza

18^{15} pm-19:^{45} pm: Projects presentation

Name		**Room (Library Ta Quang Buu building)**
Jill Brown	Helen Forgasz	702
Chronis Kynigos	JB Lagrange	704

20^{00} pm: Dinner

Tuesday, December 05, 2006

9^{00} am-10^{45} am: Sponsored workshops

10^{45} am-11^{15} am: Coffee Break

11^{15} am-12^{30} pm: Paper presentations

Session I 704, Library Ta Quang Buu building	**Session II** 722, Library Ta Quang Buu building	**Session III** 702, Library Ta Quang Buu building	**Session IV** 721, Library Ta Quang Buu building	**Time**
John Monaghan	Carolyn Kieran	Rudolf Straesser	Maria Dolores Lozano	11.15
Lulu Healy	Chris Sangwin	Vincent Geiger	Richard Noss	11.40
Merrilyn Goos	Jim Ridgway	Nathalie Sinclair	Peter Boo	12.05

12^{30} pm-14^{00} pm: Lunch

14^{00} pm-15^{45} pm: Working Groups, Study session 3

15^{45} pm-16^{15} pm: Tea Break

16^{15} pm-18^{15}am: Plenary Panel

Celia Hoyles (chair), Ivan Kalas, Richard Noss, Luc Trouche, Uri Wilensky

18^{15} pm-19:^{45} pm: Projects presentation

Name	**Room (Library Ta Quang Buu building)**
Dave Pratt, Niall Winters	702
Chantal Buteau	704
Ferdinando Arzarello	722

20^{00} pm: Dinner

Wednesday, December 06, 2006

9^{00} am-10^{45} am: Plenary Panel

Douglas Butler, Nicholas Jackiw, Jean-Marie Laborde, Jean Baptiste Lagrange (chair), Michal Yerushalmy.

10^{45} am-11^{15} am: Coffee Break

11^{15} am-12^{30} pm: Working Groups, Study session 4

12^{30} pm-14^{00} pm: Lunch

14^{00} pm: Excursion

Thursday, December 07, 2006

9^{00} am-10^{45} am: Plenary Panel

Alexei Semenov, Cyril Julie (chair), Ana Isabel Sacristan

10^{45} am-11^{15} am: Coffee Break

11^{15} am-12^{30} pm: Working Groups, Study session 5

12^{30} pm-14^{00} pm: Lunch

14^{00} pm-16^{00} pm: Working Groups, Study session 6

15^{00} pm-16^{30} pm: Tea Break

16^{30} pm-18^{00}am: Plenary reports presentation from working groups

18^{30} pm: Banquet and Cultural evening

Friday, December 08, 2006

9^{00} am-10^{00} am: Plenary reports presentation from working groups

10^{00} am-10^{30} am: Coffee Break

10^{30} am-11^{45} am: Keynote

Michèle Artigue

11^{45} am-12^{15} pm: ICMI and Closing ceremony

12^{15} pm-13^{30} pm: Lunch

13^{30} pm-16^{30} pm: School visit

Plenaries and Panels

Programme of Plenaries and Panels

Monday, December, 04, 2006
Meeting Hall, C2 building
10^{00} am-11^{15} am: Keynote: From Math Wars to the New New Math
Seymour Papert

Tuesday, December, 05, 2006
702, Library Ta Quang Buu building
16^{15} pm-18^{15} pm: Plenary Panel: Connectivity
Celia Hoyles (chair), Ivan Kalas, Richard Noss, Luc Trouche, Uri Wilensky

Wednesday, December, 06, 2006
Meeting Hall, C2 building
9^{00} am-10^{45} am: Plenary Panel: Design for Transformative Practices
Douglas Butler, Nicholas Jackiw, Jean-Marie Laborde, Jean Baptiste Lagrange (chair), Michal Yerushalmy.

Thursday, December, 07, 2006
Meeting Hall, C2 building
9^{00} am-10^{45} am: Plenary Panel: Regional Presentations from Selected Continents: Celebrating Diversity
Alexei Semenov, Cyril Julie (chair), Ana Isabel Sacristan

Friday, December, 08, 2006
Meeting Hall, C2 building
10^{30} am-11^{45} am: Keynote: The Future of Teaching and Learning Mathematics with Digital Technologies.
Michèle Artigue

Abstracts of plenaries and panels

Monday, December 04, 2006, 10^{00} am-11^{15} am

Meeting Hall, C2 buiding

Keynote: From the Math Wars to the New New Math

by Seymour Papert, Massachusset Institute of Technology (USA)

The "Math Wars" (Google this!) pit Reformers against an Unholy Alliance of Mathematicians and Back-to-Basics fundamentalists. The principled conflict is between rigor and engagement: the Reformers use slogans like engaged, child-centered and authentic; the Mathematicians accuse them of producing a "fuzzy math" stripped of the essence of mathematical thinking. Both sides are right in the values they assert. Both are wrong in posing the problem as traditional mathematics VS a stripped version thereof. Adopting principles of computation (including but not confined to programming) as the new Basics opens the possibility of creating a new math that is more engaging than what the Reformers propose and more rigorous than what the Alliance defends. My proposed design principles include: (1) Learn from the Old new Math: it went in such a wrong direction that it almost defines what needs to be done as "do the opposite" and (2) Assume full time access to computers, which opens the interesting possibility that developing countries adopting the "100 dollar laptop" will lead the way in the development of a new approach to mathematics education.

Tuesday, December 05, 2006, 16[15] pm-18[15] pm

702, Library Ta Quang Buu building

Plenary Panel: connectivity

Participants: *Celia Hoyles, Institute of Education, University of London, UK (chair), Ivan Kalas, University of Bratislava, Slovakia, Richard Noss, London Knowledge Lab, Institute of Education,University of London, UK , Luc Trouche, INRP, France, Uri Wilensky, North Western University, Chicago, USA*

Participants in the panel will present their specific vision and experience of exploiting connectivity to promote mathematics learning. Panelists will each summarise the aims of their work, demonstrate their approach in ways that will draw in the audience, and end by giving some results and implications for learning mathematics and the practice of mathematics. In the final discussion, panelists will discuss and seek to draw out some common threads concerning the implications of connectivity for theory and practice, its potential and constraints, with special consideration of issues of access and diversity. At this point there will also be opportunity for interaction between panellists and conference delegates. Celia Hoyles will chair the panel and introduce issues derived from her own experience and research, where appropriate.

Wednesday, December 06, 2006, 9[00] am-10[45] am

Meeting Hall, C2 building

Plenary Panel: Design for transformative practices

Participants: *Douglas Butler, ICT Training Centre UK; Nicholas Jackiw, KCP Technologies, Inc.,USA; Jean-Marie Laborde, Cabrilog, France; Jean Baptiste Lagrange, IUFM Reims, France (chair); Michal Yerushalmy, Technion Israel.*

Contributions to the panel will demonstrate the potential and specific affordances of digital technologies for learning mathematics, discuss the constraints and challenges involved in designing tools that can enhance and transform student mathematical activity as well as support curricular evolutions. The panellists will each present their specific vision and experience before responding to interactions from conference delegates.

Thursday, December 07, 2006, 9^{00} am-10^{45} am

Meeting Hall, C2 building

Plenary Panel: Regional presentations from selected continents: celebrating diversity

Participants: *Alexei Semenov, Russia; Cyril Julie, South Africa (chair); Allen Leung, China; Ana Isabel Sacristan, Mexico.*

This plenary panel will present short reflections on the use of digital technologies in mathematics from a regional perspective. It is especially relevant to the meeting given its emphasis on learning from cultural diversity. Contributors will very briefly summarise some of the major uses of digital technologies in mathematics in their country while if possible referring to other countries in the region for comparison or contrast. We hope that the panel will demonstrate the diversity of use but also raise challenges that specifically address issues of mathematics teaching and learning.

Friday, December 08, 2006, 10^{30} am – 11^{45} am

Keynote: The future of teaching and learning mathematics with digital technologies

by Michèle Artigue, Université Paris 7, France

About twenty years separate the first Study ICMI devoted to technology from this one. Within these two decades, the technological landscape has seriously evolved. The technological tools on which the first study focused represent only a reduced part of the digital technologies that are or can be used for mathematics teaching and learning today and the creativity in terms of technology seems endless. The way digital technologies affect the functioning of our societies has also dramatically changed with evident consequences on education at large. Technology has no longer only a positive image and equity issues hardly evoked twenty years ago are now on the front of the scene, as reflected by the discussion document.

In these two decades too, research has developed all around the world; theoretical constructs have emerged in order to help us address technological issues in mathematics education; experiments have been carried out and substantial results obtained. Where are we now? And up to what point is the knowledge we have gained useful for thinking the future of teaching and learning mathematics with digital technologies? What educational needs do we face today and what could be a reasonable agenda for research and development work in this area?

In this lecture, building on my personal knowledge of the field and on the contributions to the Conference, I will globally address these questions, structuring the lecture around three perspectives that, in my opinion, are especially insightful in order to reflect on the potential and limitation of what has been achieved so far for thinking about the future: the theoretical perspective, the teacher perspective, the institutional and curricular perspective.

Parallel paper presentations (Highlights)

7th Floor, the Library Ta Quang Buu building

Monday, December 04, 2006

Session I Room 704	**Session II** Room 721	**Session III** Room 722	**Session IV** Room 702	**Time**
Ana Sacristan	Chow Ming Kong	Allen Leung	Alan Maloney	16.15
Colleen Vale	Chronis Kynigos	Arthur Lee	Ferdinando Arzarello	16.40
Jim Ridgway	Colette Laborde	Hee-Chan Lew	Maria Mariotti Fabrice Vandebrouk	17.05
John Olive	Jaap Den Hertog		Keith Jones	17.30

Tuesday, December 05, 2006

Session I Room 704	**Session II** Room 722	**Session III** Room 702	**Session IV** Room 721	**Time**
John Monaghan	Carolyn Kieran	Rudolf Straesser	Maria Dolores Lozano	11.15
Lulu Healy	Chris Sangwin	Vincent Geiger	Richard Noss	11.40
Merrilyn Goos	Maria Mariotti	Nathalie Sinclair	Peter Boon	12.05

Programme of parallel paper presentations

7th Floor, the Library Ta Quang Buu building

Monday Session I, room 704

Name		Number	title	Time
Ana	Sacristan	c64	On the Role and Aim of Digital Technologies for Mathematical Learning: Experiences and Reflections Derived from the Implementation of Computational Technologies in Mexican Mathematics Classrooms	16.15
Colleen	Vale	c30	Gender and Socio-Economic Issues in the Use of Digital Technologies in Mathematics	16.40
Jim	Ridgway	c40	Mathematics Revisited and Reinvigorated.	17.05
John	Olive	c8	Distance Learning: Mathematical Learning Opportunities for Rural Schools in the United States	17.30

Monday Session II, room 721

Name		Number	Title	Time
Chow Ming Kong		c37	Integrating Graphic Calculator into the Singapore Junior College Mathematics Curriculum: Teacher Change	16.15
Chronis	Kynigos	c67	Half-baked Microworlds in Constructionist Tasks Challenging Teacher Educators' Knowledge	16.40
Colette	Laborde	c9	Study of a Teacher Professional Problem: How to Take into Account the Instrumental Dimension when using Cabri-Geometry ?	17.05
Jaap	Den Hertog	c55	Towards Guided Reinvention in a Multimedia Learning Environment for Prospective Teachers	17.30

Monday Session III, room 722

Name		Number	Title	Time
Allen	Leung	c65	Instrumental Genesis in Dynamic Geometry Environments	16.15
Arthur	Lee	c35	Developing Learning and Assessment Tasks in a Dynamic Geometry Environment	16.40
Hee-Chan Lew		c4	Pappus in a Modern Dynamic Geometry: An Honest Way for Deductive Proof	17. 05

Monday Session IV, room 702

Name		Number	Title	Time
Alan	Maloney	c13	Graphs 'N Glyphs as a Means to Teach Animation and Graphics to Motivate Proficiency in Mathematics by Middle Grades Urban Students	16.15
Ferdinando	Arzarello	c66	Curricular Innovation: An Example of a Learning Environment Integrated with Technology	16.40
Maria Fabrice	Mariotti Vandebrouk	c54	Developing a Joint Methodology for Comparing the Influence of Different Theoretical Frameworks in Technology Enhanced Learning in Mathematics: The TELMA Approach	17.05
Keith	Jones	c41	Theoretical Perspectives on the Design of Dynamic Visualisation Software	17.30

Tuesday Session V, room 704

Name		Number	Title	Time
John	Monaghan	c43	Teachers,Technology and Cultural Diversity	11.15
Lulu	Healy	c44	A Developing Agenda for Research into Digital Technologies and Mathematics Education: A View from Brazil	11.40
Merrilyn	Goos	c72	Understanding Technology Integration in Secondary Mathematics: Theorising the Role of the Teacher	12.05

Tuesday Session VI, room 722

Name		Number	title	Time
Carolyn	Kieran	c58	Learning about Equivalence, Equality, and Equation in a CAS Environment	11.15
Chris	Sangwin	c79	Assessment within Computer Algebra Rich Learning Environments	11.40
Maria	Mariotti	c32	New Artefacts and the Mediation of Mathematical Meanings	12.05

Tuesday Session VII, room 702

Name		**Number**	**Title**	**Time**
Rudolf	Straesser	c38	Dynamical Geometry Environments: Instruments for Teaching and Learning Mathematics	11.15
Vincent	Geiger	c60	More than Tools: Mathematically Enabled Technologies as Partner and Collaborator	11.40
Nicolas Nathalie	Jackiv Sinclair	c81	Dynamic Geometry Activity Design for the Elementary School Classroom	12.05

Tuesday Session VIII, room 721

Name		Number	Title	Time
Maria Dolores	Lozano	c19	Developing Resources for Teaching and Learning Mathematics with Digital Technologies in Enciclomedia, a National Project	11.15
Richard	Noss	c6	Designing for Diversity through Web-based Layered Learning: a Prototype Space Travel Games Construction Kit	11.40
Peter	Boon	c85	Designing didactical tools and microworlds for mathematics Educations	12.05

Parallel sponsored workshops

Location

Sponsore	Room	Location
Autograph 3	302	D6 building
Cabri	504	D3 building
Curriculum Key Press for GSP	302	D5 building
Aplusix	309	HighTech building

Program

Monday, December 04, 2006:

11^{30} am - 12^{30} pm: Cabri + Autograph (local participants)

14^{00} pm - 15^{45} pm: Cabri + Autograph (local participants)

Tuesday, December 05, 2006:

9^{00} am - 10^{00}pm: Cabri + Curriculum Key Press for GSP + Autograph+ Aplusix (local and invited participants)

14^{00} pm - 15^{45}pm: Cabri + Curriculum Key Press for GSP + Autograph (local participants)

Wednesday, December 06, 2006:

11^{15} am -12^{30} pm: Cabri + Autograph (local participants)

Thursday, December 07, 2006:

11^{15} am - 12^{30}pm: Cabri + + Curriculum Key Press for GSP + Autograph (local participants)

14^{00} pm - 16^{00} pm: Cabri + Aplusix + Autograph (local participants)

Autograph 3

Presenter: Douglas Butler, a secondary school teacher of many years, but who now runs training workshops for mathematics teachers in England and in many other countries. Douglas is a frequent speaker at international conferences, and is manager of the Autograph development team in England.

Delegates will be able to try out the successful dynamic software Autograph. Autograph has evolved from the classrooms of Oundle School in England, and gives teachers and pupils new opportunities to visualise coordinate geometry (in 2D and 3D) and probability/statistics. Autograph operates at two levels: 'Standard' (no radians, no calculus and a simplified interface) and 'Advanced'.

Autograph uses dependent, selectable objects to give a fresh view of both elementary and advanced topics, including Calculus, Trigonometry, Transformations and Vectors (in 2D and 3D), and has special tools to facilitate its use on Interactive Whiteboards. The latest version of Autograph is fully Unicode compliant for running on all languages versions of Windows.

Cabrilog

Presenter: Jean-Marie Laborde formerly Research Director (CNRS) at the university of Grenoble and now leading the Research and Development at Cabrilog.

During the last 20 years, counting to date more than 100 million users, Cabri software has become a worldwide reference to help students learn 2D and/or 3D mathematics on computers, TI graphing calculators and interactive whiteboards. Recently a wide research, led at the university of Madrid (Spain) made over 6 years on 15 000 students from secondary schools in Europe has demonstrated a 30% improvement on math learning efficiency thanks to Cabri software.

Cabri philosophy is based on direct engagement of students, giving them the simple, tailorable and intuitive tools to discover the mathematical properties, not only in the plane but also in the space.

The latest "Cabri plug-in" technology now allows teachers to insert interactive figures in Word and Powerpoint documents, as well as in web pages. This way, students who do not have a Cabri license can still visualize and manipulate the activities on those documents.

Cabri II Plus and Cabri 3D are available in more than 20 languages, including Vietnamese, Thai, Korean, and Japanese.

Participants to the workshop will learn how to take advantage of the latest Cabri products especially Cabri 3D. Connections between various math domains, especially from a geometric perspective, will be presented throughout the workshop showing the benefit of the technology from elementary school to university. It will combine visualisation, computation and geometric construction.

Iteration with Sketchpad (Key Curriculum Press)

Presenters: Steven Rasmussen, President, Key Curriculum Press, Inc. ; Nicholas Jackiw, CTO, KCP Technologies, Inc.

This hands-on workshop will introduce The Geometer's Sketchpad software, and then focus on its iterative capabilities to explore iterative mathematical concepts that occur across the school mathematics curriculum. Numeric iteration topics will range from simple number patterns (middle school mathematics) through sequences and series and integration (calculus); geometric iteration topics will range from repetitive constructions (tessellations, wallpaper groups) to recursively defined geometric structures (fractals and dynamical systems).

Metah (Aplusix)

Presenter: Hamid Chaachoua (IMAG, Grenoble, France).

Aplusix is a piece of software for arithmetic and algebra which lets students solve exercises and provides feedback: it verifies the correctness of the calculations and of the end of the exercises. Experiments in several countries and in several situations, from 2002, have had very positive results, measured with pre-test and post-test.

Aplusix has 4 types of activities: (1) Training where students benefit of feedbacks at any moment; (2) Test where students have no feedback and limited time; (3) Self-correction where students see a test they passed with feedbacks and correct their errors; (4) Observation where students or teachers see a previous work, action by action.

Aplusix has: (1) 400 patterns of exercises, organized by type and level; (2) Parameters for customization by the teacher; (3) Statistics on attempted/well-solved exercises and calculation errors; (4) An application for building exercises and problems; (5) An administration application.

The workshop will present the main functionalities of Aplusix. The participant will use software, playing the role of a student, then the role of a teacher.

Information about UNESCO

Through international cooperation and partnerships, UNESCO organizes activities, especially in developing countries, to promote capacity-building for research and advanced training in mathematics and mathematics education, and in general, to enhance public understanding and appreciation of the importance of mathematics in society and daily life.

UNESCO encourages the participation of mathematicians and mathematics teachers from developing countries by supporting ICMI Study 17 in Hanoi on 3-8 December 2006.

Within the Asia-Pacific region, UNESCO, through its Regional Bureau for Science based in Jakarta, Indonesia, supports the South East Asian Mathematical Society (SEAMS) in organizing conferences, seminars and workshops to provide a platform for promoting partnerships and collaboration among mathematicians and mathematics teachers in the region.

Contact ***Linda Santiago Posadas***
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Project presentations (Highlights)

Meeting Rooms, the 7th Floor, the Library Ta Quang Buu building

Monday, December 03, 2006, 18[15] pm-19[45] pm

Name	**Room (Library Ta Quang Buu building)**
Jill Brown, Helen Forgasz	702
Chronis Kynigos, JB Lagrange	704

Tuesday, December 04, 2006, 18[15] pm-19[45] pm

Name	**Room (Library Ta Quang Buu building)**
Dave Pratt, Niall Winters	702
Chantal Buteau	704
Ferdinando Arzarello	722

Programme

Meeting Rooms, the 7th Floor, the Library Ta Quang Buu building

Beside the activities of the conference, special time slots offer participants the possibility of presenting personal projects. Information will be given by presenters.

Monday, December 03, 2006, 18^{15} pm-19^{45} pm

Name	Project	Room
Jill Brown, Helen Forgasz	Technology in Mathematics Education: Victoria, Australia	702
Chronis Kynigos, JB Lagrange	Representing Mathematics with Digital Media	704

Tuesday, December 04, 2006, 18^{15} pm-19^{45} pm

Name	Project	Room
Dave Pratt, Niall Winters	Designing and deploying games for learning mathematics	702
Chantal Buteau	Examples of Undergraduate Student Achievement in a Technological Learning Environment	704
Ferdinando Arzarello	An example of technological integrated curriculum: the UMI proposal and the Mathematics Laboratory	722

Working groups (Programme)

Study Rooms, the Library Ta Quang Buu building

Monday, December 04, 2006

11^{30} am-12^{30} pm: Study session 1

14^{00} pm-15^{45} pm: Study session 2

Tuesday, December 05, 2006

14^{00} pm-15^{45} pm: Study session 3

Wednesday, December 06, 2006

11^{15} am-12^{30} pm: Study session 4

Thursday, December 07, 2006

11^{15} am-12^{30} pm: Study session 5

14^{00} pm-16^{00} pm: Study session 6

Theme A: Implementation of Curricula: Issues of access and equity

Room 507

Since the first ICMI Study, developments in digital technology have resulted in a range of applications for mathematics and mathematics teaching and learning. Furthermore, governments have developed policies to promote the learning and use of digital technologies throughout education systems in general as well as for mathematics learning in particular. Thus there has been some systemic implementation of digital technologies in mathematics education as a result of policy initiatives, alongside more scattered implementation as a result of specific innovations and initiatives. Neither centralised nor local initiatives have tended to result in widespread and sustained use of digital technologies in mathematics curricula and in teaching. Access to, and use of, digital technologies differs between countries, and within countries, according to socio-economic, gender and cultural factors.

The influence and place of digital technology at all levels of mathematics education provides a unique opportunity to examine reform and change in mathematics curricula and teaching by, for example, examining the political, economic, social and cultural factors that promote or impede access to and integration of digital technologies for quality learning in mathematics. Issues related to scaling up initiatives and the challenges of systemic change will be explored in this theme. We will also seek to understand how cultural practices in technology-integrated mathematics enhance, or erode, equity and agency in mathematics education.

Possible questions:

What theoretical frameworks and methodologies are helpful in understanding issues related to the widespread implementation of digital technologies for access and equity in mathematics education?

- How have mathematics curricula and values changed to reflect developments in mathematical knowledge and practices afforded by digital technologies? How should aspects of mathematics curriculum be changed in response to technology-mediated knowledge?
- How is access to digital technology impacting on the mathematical practices that occur outside of formal education settings?

- How have countries with different economic capacity or with different cultural heritage and practices implemented digital technologies in mathematics education?
- How and to what extent has the use of digital technologies in mathematics education enabled, or eroded, equity and agency in mathematics education?
- How and to what extent has technology-integrated mathematics contributed to, or reduced, differences between countries in participation and achievement in mathematics?
- What approaches, strategies or factors foster or impede the implementation of technology-rich mathematics education? What issues are involved for policy-makers, administrators and teachers for systemic change in curriculum, teaching and the organization of technology resources in educational settings?
- What have we learned about the process of change and reform in mathematics education through our successful and unsuccessful experiences of implementing digital technologies in mathematics education?
- What can students and teachers with limited access to digital technologies for mathematics learning, or access to modest technologies, do with technology that is empowering for students?
- What is the potential for creating virtual communities for mathematics learning and permitting communication between individuals from different educational settings?
- How can the use of digital technologies in mathematics education support the learning of students with special needs?
- How can digital technologies be used in mathematics learning to respond to the diverse needs of all learners, regardless of mathematics achievement, sex, class, ethnicity or cultural background?

Participants

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Theme B: Teachers and Teaching

Room 501

The integration of any new artifact into a teaching situation can be expected to alter its existing equilibrium and requires teachers to undergo a complex process of adaptation. In the case of digital technologies, the modifications required of routine practices are likely to be particularly pronounced. Not only might different pedagogical approaches be appropriate, but also the teacher needs to reconsider how the new representations and alternative learning strategies made available through technology use might change along with what could be taught, and how and when. Various frameworks, drawing from both theory and practice, are currently employed to analyse the role of the teacher in orchestrating technology-integrated mathematics learning. This theme will consider the complementarities and contrasts between these frameworks and how they are operationalized in the face of ever-evolving resources. It will also address implications of these complex issues for pre-service and for ongoing teacher professional development.

Possible questions:

- What theoretical frameworks and methodologies illuminate the teacher's role in technology-integrated environments for mathematics learning?
- What kinds of pedagogical approaches and classroom organizations can be employed in technology-integrated environments including distance teaching and how can they be evaluated?
- How can a focus on technological tools help us understand the ways in which mathematical practices and the roles of the teacher vary across settings?
- How can teachers be supported in deciding why, when and how to implement technological resources into their teaching practices?
- What kinds of pre-service education and professional development programs are appropriate to prepare teachers to use technology in their mathematics classrooms and to help them to sustain ongoing use?
- What can we learn from teachers who use, or who have tried to use, digital technologies for mathematics teaching?
- How are teachers' beliefs, attitudes, mathematical and pedagogical knowledge shaped and shaped by their use of digital technologies in mathematics teaching and how are these issues influenced by access to resources and by differences in culture?

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Theme C: Learning and assessing mathematics with and through digital technologies

Room 721

This theme will concentrate on developing understandings of how students learn mathematics with digital technologies and the implications of the integration of technological tools into mathematics teaching for assessment practices. Its foci will include consideration of how digital technologies might be employed to open windows on learners' developing knowledge, and on how interactions with digital tools mediate learning trajectories. Additionally, the theme will address the challenges involved in balancing use of mental, paper-and-pencil, and digital tools in both assessment and teaching activities.

Possible questions:

- What theoretical approaches and methodologies help to illuminate students' learning of mathematics in technology-integrated environments? What are the relationships between these approaches and how do they compare or contrast with other theories of mathematics learning?
- How does the use of different digital technologies influence the learning of different mathematical concepts and the shape of the trajectories through which the learning develops?
- How can technology-integrated environments be designed so as to capture significant moments of learning?
- How can the assessment of students' mathematical learning be designed to take into account the integration of digital technologies and the ways that digital technologies might have been used in the learning of mathematics?
- How can and should learning and assessment practices reflect differences in resource level and in cultural heritage?
- How can the benefits of existing technologies be maximised for the benefit of mathematics teaching and learning?
- What is the potential contribution to mathematics learning of different levels of interactivity and different modalities of interaction, and how might this potential be realised?
- What is special about the potential of collaborative study of mathematics whilst physically separated, and how might this potential be harnessed so as to support mathematics learning?

- What is the potential for creating virtual communities for mathematics learning and permitting communication between individuals from different educational settings?
- What new types of mathematical knowledge and practices emerge as a result of access to digital technologies, particularly computational, dynamic visualisation and communication technologies, for example in a mathematics laboratory?

Participants

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Theme D: Design of Learning Environments and Curricula

Room 508

The purpose of this theme is to focus closely on the issues and challenges involved in designing mathematics learning environments that integrate digital technologies while recognising that the tools made available in such environments can and do shape mathematical activity in ways that to some extent are predicable and in some not. In addition to considering the specific affordances and constraints of different digital technologies for structuring mathematical learning experiences (including various software packages, hardware configurations and the Internet), this theme will consider the implications of design decisions on tools, curriculum, teaching and learning.

Possible questions:

- What theoretical frameworks and methodologies are helpful in understanding how design issues impact upon the teaching and learning of mathematics?
- How does the use of different technology-integrated environments both influence the learning of different mathematical concepts and shape the trajectories through which the learning develops?
- How can technology-integrated environments be designed so as to foster significant mathematical thinking and learning opportunities for students?
- What kinds of mathematical activities might different digital technologies afford and how can learning experiences (including the tools, the tasks and the settings) be designed to take advantage of these affordances?
- How can technology-integrated learning environments be designed so as to remain sensitive to persistent challenges, for example swift and inevitable obsolescence and ongoing maintenance costs?
- How can technology-integrated learning environments be designed so as to influence and change curriculum, and how can this be achieved consistently over time?
- How are new types of technology-mediated mathematical knowledge and practices related to current classroom curricula and values, and how should aspects of mathematics curriculum therefore be deleted or changed?

Participants

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Social program

A: **Sunday, December 03, 2006 (Evening)**

Welcome party of the Organizing Committee

Address: the 10th floor, Library Ta Quang Buu building

Begin: **19^{30} pm**

B: **Wendnesday,December 06, 2006 (Afternoon)**

Visit Hanoi (following the invitation of the Organizing Committee)

Bus transportation from Hanoi University of Technology at **13^{30} pm**

Bus Tour: Visit Vietnam Museum of Enthology, Temple of Literatures, Pupet theatre.

C: **Thursday, December 07, 2006 (Evening)**

Conference Banquet with Vietnamese traditional music

(Dinner on invitation of the Rector of Hanoi University of Technology)

Bus transportation from Hanoi University of Technology at **18h00 pm**

D: **Friday, December 08, 2006 (Afternoon)**

Visit Chu Van An High School

(Evening Party on invitation of the Headmaster of Chu Van An school)

Bus transportation from Hanoi University of Technology at **13^{30} pm**

E: **Saturday, December 09-10, 2006**

Excursion to Halong bay

Departure: will be announced on the conference

Arriving: will be announced on the conference

List of Contributions

–P–

–R–

–S–

–V–

–W–

ABSTRACTS

Design and Understanding

Janet Ainley and Dave Pratt

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Abstract. We explore ways in which access to technological tools can support new approaches to the design of pedagogical tasks and at the same time is providing us with new insights about the nature of mathematical understanding. We describe a novel approach that situates the challenge of designing pedagogic tasks in the same framework as that of locating mathematical understanding. An example of the use of this design approach is explored.

Mathematics investigations: Towards curriculum design and implementation

Mara Alagic

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Instrumented techniques in tool - and object Perspectives

Mette Andresen

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Abstract. The aim of this paper is to report from a study of the role of instrumented techniques in the students' learning process. The paper analyses an episode from a case study of students solving differential equations in a CAS environment. The analysis demonstrates how tasks can be designed with the aim to encourage the students to change between the perspective of tool on a mathematical conception and the perspective of object on the conception. Reasons are given in the paper for the assertion, that changing between these two perspectives supports the instrumental genesis as well as the conceptual development.

Connecting Grade 4 students from diverse urban classrooms: virtual collaboration to solve generalizing problems

Ruth Beaty and Joan Moss

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Abstract. We have been investigating the potential of a web-based collaborative workspace, Knowledge Forum (Bereiter & Scardamalia, 2003), to support Grade 4 students in generalizing with patterns as part of our research in early algebra. Our hypothesis was that incorporating Knowledge Forum, with its underlying knowledge building principles, might offer an authentic platform for developing students' mathematical discourse. We present analyses of the Knowledge Forum database from a recent study in which three diverse urban classrooms were linked electronically to collaborate on solving a series of generalizing problems. Analyses of contributions to the database revealed that the opportunity to work on a student-managed database supported students in developing a community practice of offering evidence and justification for their conjectures. The database also provided students with the time and software capability to revisit and revise their notes and to develop a level of discourse that elicited high-level mathematical problem solving.

Providing mathematics e-content

Emran Behrooz

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Abstract. Mathematics learning seems to be hard and exhausting task for many learners. Mathematics educators and teachers always try to stimulate the public and specially students for studying mathematics. Certainly ICT is an effective tool for providing an interesting atmosphere for mathematics learning. Using this tool, one can make some virtual spaces such as exact diagrams and figures, attractive animations, and most important, making games and parametric programs to provide mutual interactions between learners and teaching media, such that they can change the parameters and see the results in figures or in the processes of the programs and much easier understand the concepts. Isfahan Mathematics House (IMH) was trying to organize content provider teams of these specialists and professionals as its member: Mathematics educator, Mathematicians, Scenarists, Graphic experts and Programmers and multimedia experts. The team was making up some mathematics contents, but it faced to a big problem. It was the lack of communication between these people since many of them don't understand others with different background. For example the art experts don't understand mathematics and vice versa. As a solution we tried to train some "interpreters" who can understand or have more feeling of both sides, and finally some successful results raised. In this article we are trying to report these activities with many useful experiences for all interested in the process of providing mathematical e-content.

Designing Didactical Tools And Microworlds For Mathematics Educations

Peter Boon

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Abstract. This paper reports on the extensive design activities by the Freudenthal Institute over the last few years in the field of small didactical tools and microworlds (javaapplets). New technologies have led to new ideas on visualising and learning mathematics. The effort made in several development and implementation project shave resulted in a collection of robust and well-tested didactical tools. Many of these applets have found their way to the practice of mathematics education and many schools work with these new tools. More research is still needed though (and planned) to obtain a detailed image of the possibilities and constraints of these new tools and their role in longer learning trajectories.

Developing a joint methodology for comparing the influence of different theoretical frameworks in technology enhanced learning in mathematics: the TELMA approach

TELMA (KALEIDOSCOPE) European Research Team:
Artigue M., Bottino R., Cerulli M., Mariotti M., Morgan C. & Alexopolou., Cazes C., Chaachoua H., Georget J.P., Haspekian M., Kynigos C., Lagrange J.B., Latsi M., Maffei L., Maracci M., Papadopulou A., Pedemonte B., Psycharis G., Robotti E., Souchard L., Trgalova J., Vandebrouk F.

Looking through zones at the teacher's role in technology-rich teaching and learning environments (TRTLE's)

Jill P Brown

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Abstract. The equilibrium of teachers and teaching is inevitably altered by the availability of electronic technologies. It is imperative to establish what it is that enables teachers to perceive, attend to, and exploit affordances of the technology salient to their teaching practice and likewise for students in their learning about function. This paper focuses on one teacher and his teaching where technology use is expected by curriculum authorities. The aim is to show how Valsiner's zones and Gibson's affordances have been used as a theoretical framework to document the teacher's role in integrating electronic technologies into his teaching. The students' subsequent use of technology to support their learning is also examined. Thematic matrices have been used to identify manifestations of affordances, affordance bearers used, and the conditions enabling perception or promoting enactment of particular manifestations of affordances. These conditions, the latter indicative of the Zone of Promoted Action, have been used to identify teacher's role as he canalises students' current and future thinking about concepts and methods taught. The teacher's approach also impacts on the Zone of Free Movement/Zone of Promoted Action complex of the future.

Evolving technologies integrated into Undergraduate mathematics education

Chantal Buteau and Eric Muller

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Abstract. This submission focuses on the design of learning environments and curricula and describes a twenty-five year evolution of integrating digital technology3 in the teaching and learning of mathematics at Brock University. It provides information on actual uses of technology in university level programs for students, majoring in mathematics, or taking mathematics for their major in another discipline, or aiming to be teachers. A brief history explains the ever increasing use of established mathematics and statistics computer systems in courses and programs until the Department had gained enough experience with technologies to institute a new core mathematics program MICA (Mathematics Integrating Computers and Applications). Student interest in the MICA program is demonstrated by a threefold increase in mathematics majors. The submission pays special attention to the role of the teacher. First, a new faculty member reflects on the teaching adjustments she made to teach in a department that has built an array of technologies into its courses. Second, it explains how technology, in a first year core mathematics course, helps to shift the mediator responsibilities from the teacher to the student. Of particular significance is the students' enthusiasm and willingness to work beyond all expectations on their main project in which they construct Learning Objects.

Varying pedagogical media: How interaction with spreadsheets might mediate learning trajectories

Nigel Calder

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Abstract. This paper is concerned with the use of spreadsheets within mathematical investigational tasks. Considering the learning of both children and pre-service teaching students, it examines how mathematical phenomena can be seen as a function of the pedagogical media through which they are encountered. In particular, it shows how pedagogical apparatus influence patterns of social interaction, and how this interaction shapes the mathematical ideas being encountered. Notions of conjecture are considered, and the trajectories learners negotiate as they settle on sub goals, reflect on output, and further develop their emerging theory. The particular faculty of the spreadsheet setting is examined with regard to the facilitation of mathematical thinking. Employing an interpretive perspective, a key focus is on how alternative pedagogical media and associated discursive networks influence the way that students form and test informal conjectures.

An emergent field of enquiry: the introduction in the classroom of E-Exercise Bases

Claire Cazes, Fabrice Vandebrouck

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Abstract. Investigating on E-Exercise Bases (EEBs) is a necessity. This presentation successively focuses on teachers, students and mathematics. The anthropological approach and the methodological individualism frame account for some regularities and disparities in teachers' and students' attitudes towards these tools and specify the kind of mathematical work accomplished. The results presented here are based upon observations in various French high schools and universities.

Rethinking the terrain in terms of schemas as epistemological structures

Mohan Chinnappan

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Abstract: In this discussion I wish to tackle the issue of how digital technologies (DTs) shape teaching and learning of mathematics. Teachers and students of mathematics use DTs in a multitude of ways to enhance mathematical understandings but there is limited information about the directions and nature of shifts in the conceptual ground gained by the learners and its relationship to pedagogical strategies adopted by teachers. The issue will be examined within the framework of schemas as epistemological structures. Working on the view that schemas provide visual representations of what is learnt, I propose to analyse a series of activities by students and teachers that involve the active use of a variety of DTs. The impact of DTs on students' and teachers' prior knowledge, and the extension of that knowledge will be a principal consideration.

Integrating Graphic Calculator into the Singapore Junior College Mathematics Curriculum: Teacher Change

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Abstract. In Singapore, the revised junior college mathematics curriculum implemented in 2006 has specifically identified the graphic calculator as an important tool in the teaching and learning of advanced level mathematics topics (MOE, 2004). The study described here, which is part of my PhD thesis, investigates teacher change, in a time of transition from a classroom without graphic calculator use, to teaching in a classroom where graphic calculator has the potential to be an integral part of students' learning of mathematics. This study carried out in 2006 specifically seeks to describe how the concerns of teachers, the teaching strategies of teachers and the roles of teachers change when they integrate graphic calculator into the junior college mathematics curriculum. The study also aims to identify important features among teachers who are successful in integrating graphic calculator into the curriculum. This study is anticipated to complete by end 2006. The contributions from this study will be discussed in anticipation to theme B on teachers and teaching.

Graphs ‘N Glyphs as a Means to Teach Animation and Graphics to Motivate Proficiency in Mathematics by Middle Grades Urban Students

Jere Confrey, Alan Maloney, Lewis Ford, and Kenny Nguyen

Washington University in St. Louis

Abstract. The Graphs ‘N Glyphs mathematics education initiative aims to provide a model for filling the need of under-resourced urban students to become proficient both in the mathematics necessary to successfully pursue high school and advanced mathematics, and in electronic technologies required for robust economic and employment prospects. Grounded in learning progressions and modeling approaches to multiplicative reasoning, the multi-representational software provides a microworld-type environment in which students learn the mathematics underlying 2-D and 3-D animation and computer graphics, in order to produce their own increasingly realistic and complex computer animations. Ultimately the project aims for students to build explicit mathematical proficiency with rational numbers, ratio, proportion,fractions and decimals, as well as periodic functions and early trigonometric reasoning, in a motivating context of a computer animation and graphic design. Level one of the project focuses on object construction on the coordinate plane; congruence,similarity, reflection and scaling through tessellations; ratio as the foundation of both translation and scaling; and, finally, designing original animations.

Developing Dynamic Sketches for Teaching Mathematics in Basic Schools

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Abstract. Reflecting on the actions and activities that are enabled by a new technology can catalyze a reconceptualization of the content and methods of teaching mathematics. Software might provide tools that enhance students' actions and imagination. The five years long research has been developed on two phases. The first phase was to analyze problematic dimensions of teaching mathematics in schools using computer-based technologies and searching the most suitable software for the National curriculum of mathematics. The next step was to investigate (also to localize) the Geometer's Sketchpad and to built the various sets of dynamic sketches for teaching and learning mathematics in basic schools. More than 800 dynamic sketches have been developed within 9th and 10th grades (years 16 and 17) mathematics curriculum. Two CDs and descriptions have been prepared and published. The paper explores the main questions of developing dynamic sketches for mathematics curriculum of basic school in Lithuania.

A pedagogy-embedded Computer Algebra System as an instigator to learn more Mathematics 1

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Abstract: The constraints of a Computer Algebra System are generally classified as internal constraints, command constraints and organization constraints. In fact, a fourth kind of constraints exists, namely motivating constraints. These constraints consist in features or commands of the CAS whose understanding demands sometimes from the user to acquire more mathematical knowledge than what has been taught in a standard course. Theorems can appear which necessitate learning beyond the syllabus framework. Such "new" theorems appear generally in two situations, namely when using a pedagogy-embedded feature of the CAS (either a posteriori help, or a priori hints), or when using certain commands and trying to analyze the results. We describe a research frame in the first year Foundation Courses in Mathematics, in our Engineering College. With this research, we wish to understand more deeply the instrumentation processes at work with the students and to check motivations for a change in the institution's culture.

Towards guided reinvention in a multimedia learning environment for prospective teachers

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Abstract: This paper discusses the role of a multimedia learning environment, MILE, for the learning processes of prospective teachers. MILE is a Multimedia Interactive Learning Environment for prospective primary school teachers, with content for primary mathematics teachers' education programs. We summarize an investigation on student-teachers' use of language and how they give meaning to mathematics and didactics. Our analysis shows: (1) the evolving and shifting nature of meanings and processes of signification; (2) the important role of experiences from the past, but in particular from their work as trainees at primary schools; (3) the use of mathematical language and the consequences for a didactical way of thinking; (4) how student-teachers' observations lead to hypotheses and local theories. In our conclusions, we related our findings to the construction of a teacher education course that allows student-teachers to use MILE to develop mathematic and didactical insights on materializing. Teacher educators need help to capitalize on crucial moments in the interaction amongst student teachers. The study showed that the teacher educator needed resources to recognize those moments and to optimize class discussions.

Using Robots to Learn Functions in Math Class

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Abstract. In the present paper we present and discuss an activity realized with K-8 level students using robots to learn functions in the mathematics classroom. Research presented in this paper is framed by project DROIDE which is a three years project. We are now in the first one. The aims of DROIDE are:

• to create problems in Mathematics Education/Informatics areas to be solved through robots;

• to implement problem solving using robotics in three kinds of classrooms: mathematics classes at K-9 and K-12 levels; Informatics in K-12 levels; Artificial Intelligence, Didactics of Mathematics and Didactics of Computer Science/Informatics subjects at high level;

• to analyze students activity during problem solving using robots in this different kinds of classes.

In spite of we are just beginning the research, first data collected show them as promising and we can already point out some implications for mathematics teaching and learning when robots are used as mediators between students and Mathematics.

Gender, equity, teachers, students and technology use in secondary mathematics classrooms

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Abstract. In recent years we have been researching a range of issues associated with the use of digital technologies – computers, graphics calculators, and CAS calculators – in secondary mathematics classrooms. Gender and other equity considerations were a focus in some of the work; teachers' and students' beliefs about and attitudes towards the technologies were also central. In all of the studies, comparisons were made. The views of male and female students and teachers have been examined, students' and teachers' views compared, the perspectives of teachers in different countries contrasted, teachers' views on computers and calculators distinguished; and the examination results of male and female students using different digital technologies explored. In this proposal, synopses of various dimensions of a selection of the studies are presented. Taken together the studies reveal that gender differences favouring males with respect to technology use are evident, that teachers are generally supportive of the use of digital technologies for mathematics learning, and that curricular and school factors are associated with the classroom use of technologies and beliefs about their efficacy in fostering student learning.

Development and Introduction of the New Content of Mathematics in Secondary Schools in Latvia

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Abstract. This writing examines the possibilities for and principles of developing and implementing a new math curriculum into the Latvian secondary education. To get a better understanding of the Latvian situation, we are offering a brief insight into the existing educational system. The existing standard and sample curricula for teaching math have become outdated and work is being done on developing a new standard and curriculum.The real life situation in Latvia with regard to the serviceability and availability of computers and the pupil's access to computers for learning math has been identified. The conclusion is that pupils use computers mainly in classes of computer studies, but very in little in math classes. Some research which directly deals with this particular problem is presented. When designing the new curriculum, our attention is focused on how to use the computer in teaching math while preventing its use as a means in itself. Our approach is underpinned by objectives, tasks and philosophy of teaching math that would result in engaging the modern day technologies. In Latvia a new extensive project has started - "Curricula development and further education in science, mathematics and technology related subjects". A brief overview of the project performance with project objectives and developed products is presented. Some of the potential problems are considered that need be avoided in order to ensure the projects sustainability. The project is unique to Latvia and one of its central objectives is (through the standard, curricula and teacher support material) to demonstrate to teachers what, how and why to teach math in secondary school with the help of the computer. The project's implementation will allow us to introduce a unified concept for the teaching of science and math at the national

level.The tasks of education are to prepare a pupil for life and for further education. In order to accomplish that, the main focus should be placed on three activities: imparting knowledge, evaluating and making it practical (including creativity). Learning mathematics is essential for all three activities mentioned above.

Learning communities with a focus on ICT for inquiry in mathematics - affordances and constraints in development of classroom practice

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Abstract: In this paper I will report from research on use of ICT tools to promote students' learning of mathematics. The work is largely situated in a learning community with teachers and didacticians working together on planning for an inquiry approach to learning mathematics. A sketch of theoretical framework is presented with emphasis on seeing ICT as a personal technology, developing into an instrument for the learner and with considerations of affordance and constraints to analyse the activities. I will present and analyse cases of teachers and students' work on mathematics in the classrooms using ICT tools. I will focus on how the teachers plan for and support the students' learning in the classroom. In particular I will focus on how mathematical concepts and relations are represented in the work.

More than Tools: Mathematically Enabled Technologies as Partner and Collaborator

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Abstract: This paper theorises an extension to a framework that describes students' use of technology when engaged in mathematical activity and discussion. The framework describes students'interaction with technology through a series of metaphors: technology as master; technology as servant; technology as partner; and technology as extension of self. These metaphors allow illustration of potential relationships between students'intentions, technological engagement and actions. The framework is conceptualized from within a socio-cultural perspective of learning/teaching mathematics and extends the Vygotskian principle of Zone of Proximal Development (ZPD) by elevating computer and graphing calculator technologies beyond that of simple cultural tools to that of quasipartner or mentor. The framework was developed through an ethnographic case study of a single class of students over a two year period. It describes different types of interaction between technology and students as they are challenged by new ideas and concepts or as they explore non-routine, contextualized mathematical problems. A component of the framework is used to analyse two episodes of student/student and student/technology interaction while working on a specific mathematical task. Implications are discussed for the use of the extension of this framework as a means for the promotion of more sophisticated uses of technology in mathematics classrooms.

Understanding technology integration in secondary mathematics: Theorising the role of the teacher

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Abstract. Previous research on computers and graphics calculators in mathematics education has examined effects on curriculum content and students' mathematical achievement and attitudes while less attention has been given to the relationship between technology use and issues of pedagogy, in particular the impact on teachers' professional learning in specific classroom and school environments. This observation is critical in the current context of educational policy making, where it is assumed – often incorrectly – that supplying schools with hardware and software will increase teachers' use of technology and encourage more innovative teaching approaches. This paper reports on a research program that aimed to develop better understanding of how and under what conditions Australian secondary school mathematics teachers learn to effectively integrate technology into their practice. The research adapted Valsiner's concepts of the Zone of Proximal Development, Zone of Free Movement and Zone of Promoted Action to devise a theoretical framework for analysing relationships between factors influencing teachers' use of technology in mathematics classrooms. This paper illustrates how the framework may be used by analysing case studies of a novice teacher and an experienced teacher in different school settings.

The Unrealized Potential of the Internet

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Abstract. The role of the Internet in teaching and research has been given too little attention in mathematics education, particularly in developing countries and underserved segments of the population of developed countries. Those with inadequate Internet connectivity lack access to the research of others and experience difficulty in achieving recognition for their own work. Exchange of ideas in their formative stage as well as the distribution of completed writing is essential for full participation in the research community. Similarly, use of the Internet to share experience and innovation in teaching and to train teachers in-service and pre-service is a cost-effective means of instituting widespread improvements, particularly with respect to increasing access for groups such as girls, adult learners, rural or disadvantaged populations, and the learning disabled. For the learners themselves, the ability to acquire information via the Internet can transform their educational experience. Although there is concern about the hegemony of developed nations in the Internet environment, the solution is inclusiveness, not isolation, as well as sharing within domestic culture. Although investment will be required, new technology and focus on community-based access will reduce the costs of providing adequate communications infrastructure.

Learning mathematics in class with online Resources

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Abstract. Internet resources proposing mathematics exercises with an associated environment are frequently used in class, in many countries and for all levels. I address here the question of the theoretical approaches that can be used to describe and understand the way students work and learn mathematics with these resources. I study in particular the possibilities offered by the instrumental approach, complemented by the notion of didactical contract. The resources considered are complex. In order to study their use by students, is thus necessary to consider two activity levels: the resolution of one exercise, where students use the elements of the exercise's environment (feed-back, hint etc.) and the level of a whole session, where students develop working patterns. I describe on examples extracted from various teaching designs how the instrumental approach, and the notion of didactical contract, can help on each level to interpret the students' behavior with the resource. It permits to establish links between the behaviors and the mathematical knowledge involved, and to make a first step towards the consequences on the learning processes.

A developing agenda for research into digital Technologies and mathematics education: A view from Brazil

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Abstract. This article aims to introduce the research agenda that is currently guiding activities in the group Tecnologias e Meios de Expressão em Matemática1 (TecMEM) of PUC-SP. It describes how wide scale attempts to insert digital technologies into Brazil's public schools system have tended to emphasize the computer as a catalyst for pedagogical change, without acknowledging the epistemological and cognitive dimensions associated with such change or the complexity associated with the appropriation of tools into mathematical and teaching practices. To focus research efforts on learning ecologies as complex interacting systems, the paper presents how our group is adopting as a research strategy the involvement of teachers and students in the process of collaborative tool design.

Functionalities of technological tools in the Learning of basic geometrical notions and properties

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Abstract. This contribution presents the comparisons made by two students, each the most advanced in their classes, of the relative functionality of a variety of technological tools, the ones they had used to learn basic geometric notions and properties. This work is part of a line of investigation specializing in the functionality of artifacts involved in teaching sessions (Verillon and Rabardel, 1995) and the development of classroom discourse (Sfard, 2001). It revisits the case of "Guillermo" (Hoyos, 2003), a junior high school student who learns the topic of geometric transformations via utilization of Cabri-II and pantographs or articulated machines. Also reviewed is the case of "Marcel", a sixth grade student which takes up problem resolution involving the notions of angle, turn, and their measurement via Logo and Cabri-II. The paper argues for complementary between the tools utilized for the construction of use schema, which objectified certain mathematical notions involved; and for the internalization of instruments in use (Mariotti, 2002).

Tools rather than Toys: Fostering mathematical understanding through ICT in primary mathematics classrooms

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Abstract. The proposed paper addresses the theme "teachers and teaching" by reflecting how far a new methods course on the use of technology in primary mathematics prepares pre-service teachers to critically select and use digital and electronic technologies in classrooms. While the motivational benefit with respect to the use of ICT in classrooms is certainly an important issue, this paper seeks to highlight in how far the careful selection and reflected implementation of technologies in classrooms can help to extend mathematical understanding beyond mathematics teaching and learning with traditional classroom materials. The paper focuses on two learning environments that have been developed in the context of a university methods course and trialed in the form of teaching experiments in grade 4 classrooms by pre-service teachers.The two learning environments go beyond the use of special software designed for (primary) mathematics classrooms and involve a robot and a monitoring device. Both learning environments will be briefly introduced in terms of their technical description. In addition, selected tasks from the teaching experiments, classroom observations and examples of students' work will be presented. More detailed information as well as an evaluation of the pre-service teachers learning processes (currently in progress) would be provided during the conference presentation.

Dynamic Geometry Activity Design for Elementary School Mathematics

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Abstract. Based on our research in designing mathematics activities for the grade 3-5 classroom, we outline central issues confronting the deployment and integration of Dynamic Geometry software in the elementary school curriculum. We remark in particular on contributions of the elementary setting to specific theoretical and pedagogic issues confronted in Dynamic Geometry use in real classrooms not directly instrumented through researcher interventions, and to specific effects of Dynamic Geometry technology on students' mathematical understanding and practice.

On-line professional development for mathematics educators: Overcoming significant barriers to the modelling of reform-oriented pedagogy

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Abstract: As noted in the ICMI 17 Discussion Document, much has changed since the original ICMI 1985 study. The advent of highspeed Internet and web-based technologies has in many ways revolutionized the educational project, touching all areas of research and practice. For example, on-line course offerings in continuing teacher education are rapidly becoming standard features for faculties of education involved with the professional development of in-service teachers. However, instructors of mathematics education courses which are offered in a full distance context must navigate certain formidable obstacles in the planning and delivery of their on-line learning experience. In an era of reform-oriented mathematics education (National Council of Teachers of Mathematics, 2000; Ontario Ministry of Education, 2005), which emphasizes the increased use of manipulatives, technology, groupwork, and communication, the "virtual" instructor must develop creative methods for modelling these important aspects of teaching and learning. Based on three years (eight courses) of instructor/course evaluation feedback and on the author's own observations, the following paper presents four key strategies for bridging this technological gap in the delivery of quality on-line professional development for mathematics educators. In addressing both professional development and distance education, this paper speaks to specific questions found in both the Teachers and Teaching (3) and Connectivity and Virtual Networks for Learning (7) themes, and approaches these in terms of digital technologies and the role of the teacher.

Theoretical perspectives on the design of dynamic visualisation software

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Abstract. Designing learning environments entails drawing on theoretical perspectives on learning while, at the same time, being cognisant of the affordances and constraints of the technology. This paper reflects on the design process through utilising evidence from the design stage of the development of a dynamic visualisation software environment called 3DMath. During the development of 3DMath, a dynamic three-dimensional geometry microworld aimed at enabling learners to construct, observe and manipulate geometrical figures in a 3D-like space, the key elements of visualisation – covering mental images, external representations, and the processes and abilities of visualisation- were taken into consideration. The aim of this paper is to illustrate how the design of this particular software was informed by these elements of visualisation, as well as by theories related to the philosophical basis of mathematical knowledge and by semiotics. The paper illustrates how the features of software may be designed to take account of relevant theoretical notions and to satisfy the characteristics of instructional techniques that are appropriate to theoretical perspectives on learning.

Designing for diversity through web-based layered learning: a prototype space travel games Construction kit

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Abstract. We present a Space Travel Games Construction Kit designed to enable students to learn while building a computer game. Games are built in the context of a metagame that provides motivation, structure, guidance, and background in game making. A key design decision was to encourage layered learning through specially-designed program fragments, which the students could customize and assemble. We present some scenarios and report on the results of testing a version of the kit with students, which suggest that designing levels in the game is an avenue for further development.

IT in Singapore Mathematics Education

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The discrete continuous interplay. Will the last straw break the camel's back?

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Abstract. We investigate the influence of the technology and in particular the influence of the discrete continuous interplay, which can be demonstrated by the technology, in enhancing students' mathematical thinking. We analyze how students' awareness of the limitation of discrete numerical methods, combined with error analysis, lead to a better understanding of the continuous methods. We identify the new potential offered by the instrumented work, the way students are influenced by their interaction with the Computer Algebra System and the presence of mental images created by this interaction, even when the computer is turned off. We also identify the inability of some students to differentiate between error due to mathematical meanings and error due to meanings specific to the "instrument". Our intention is to employ the possibilities offered by the technology, to elaborate activities based on the discrete-continuous interplay and to investigate their influence on students' thinking processes in relation to the notion of limit in the derivative concept.

Learning about equivalence, equality, and equation in a CAS environment: the interaction of machine techniques, paper- and pencil techniques, and theorizing

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with the collaboration of
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Abstract: The study presented in this report is part of a larger project on the intertwining co-emergence of technique and theory within a CAS-based task environment for learning algebra, which also includes paper-andpencil activity. The theoretical framework consists of the instrumental approach to learning mathematics with technology, in particular Artigue and colleagues' adaptation of Chevallard's anthropological theory. The theme presented herein is that of equivalence, equality, and equation. Two 10th grade classes were taught by the same mathematics teacher during two successive years, using project materials designed by the research team. Classroom observations, student interviews, student activity sheets, and posttest responses were the main data sources used in the analysis. Findings attest to the intertwining of technique and theory in algebra learning in a CAS environment. In addition, the data analysis revealed that probably the most productive learning took place after the CAS techniques provided some kind of confrontation or conflict with the students'expectations, based on their previous theoretical knowledge. Even if such conflicts in applying CAS techniques may seem to be hindrances to students' progress, in fact our experience suggests that they should be considered occasions for learning rather than as obstacles. However, a precondition for these conflicts to foster learning is their appropriate management in the classroom by the teacher.

The Impact Of The Use Of Graphics Calculator On The Learning Of Statistics: A Malaysian Experience

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Abstract. Educational tool such as the graphics calculator (GC) is increasingly being used in school and college mathematics worldwide. In Malaysia, the Ministry of Education together with a couple of GC distributing companies (such as CASIO and TEXAS INSTRUMENTS) has conducted a series of GC workshops to train the secondary school mathematics and science teachers. To date, undergraduate mathematics integrating the use of GC has already been offered in the local universities. This paper emphasizes on the impact of GC in the learning of statistics. Even though many research findings have reported favourable use of GC in the teaching and learning of mathematics, the effect and the impact of GC however, could be different in a diverse learning environment. In the study conducted, students' thinking and feeling towards engaging GC in their learning process were explored through observation, students' written self-reflection and interviews. Analysis of the data highlighted three major changes in the students' learning process that engaged the use of GC. These three changes are students' perceived value of GC, changes in the norm classroom practices and changes in the perceived peer status.

Analysis of effects of tablet PC technology in mathematical education of future teachers

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Abstract. This paper presents description of authors' current and proposed work using Tablet PCs mobile computer lab in future teachers' preparation classes. Faculty from the Colleges of Education and Science at the University of Texas at El Paso worked together to study the effects of incorporating Tablet PC technology in pre-service teachers' math education. We assessed the significance of the technology by evaluating and comparing students' final project and course grades. We did a statistical comparison of two groups: the treatment group where students extensively used Tablet PCs to work on mathematical investigations and lesson plans and the control group where students worked on identical math investigations and created lesson plans without utilizing any technology. The outcome shows a greater improvement in the treatment group's mathematical content knowledge versus that of the control group's. Current and future work involves evaluation of the change in acquiring mathematical pedagogical knowledge by pre-service teachers. Future teachers (in both groups) are asked to create original math lessons using unique manipulatives and hands-on activities. Students in the treatment group are required to use Tablet PCs to create hands-on activities. Groups' pedagogical knowledge will be compared using pre/post tests, questionnaires and knowledge and attitude surveys.

What can be learned from metacognitive guidance in mathematical online discussion?

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Abstract. This study compares two mathematical online learning environments: Online learning supported either with explicit metagognitive guidance (MG) or with no metagognitive guidance (NG). The metacognitive guidance was based on three aspects: Using the IMPROVE self-metacognitive questioning method for problem solving (Kramarski & Mevarech, 2003), discussing features of mathematical explanations, and practicing ways of providing online feedback. The effects were compared between mathematical online problem solving of a real life task and students' mathematical and metacognitive discourse. Participants were 79 ninth-grade students in Israeli junior high schools. Results showed that MG students significantly outperformed the NG students in online problem solving with regard to mathematical explanations. We also found that the MG students outperformed their counterparts in various criteria of mathematical and metacognitive discourse. The practical and theoretical implications of supporting online learning with metacognitive guidance will be discussed at the conference.

Half-baked microworlds in constructionist tasks challenging teacher educators-knowledge

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Abstract. This paper illustrates how five teacher educators in training were challenged with respect to their epistemology and perceptions of teaching and learning mathematics through their interactions with expressive digital media during a professional development course. The research focused on their experience of communally constructing artifacts and their reflections on the nature of mathematics and mathematics teaching and learning with digital media. We discussed three different ways in which this media was used by the teachers; firstly, as a means to engage in techical-applied mathematics to engineer mathematical models; secondly, as a means to construct models for students to engage in experimental-constructivist activity; thirdly, as a means to engage in a discussion of a challenging mathematical problem.

Study of a teacher professional problem: how to take into account the instrumental dimension when using Cabri-geometry ?

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Abstract. The question addressed by this contribution is how teachers organize the conditions for an instrumental genesis and to what extent they foster mathematics learning through an instrumental genesis, in the case of geometry learning and teaching based on the use of a dynamic geometry software. The contribution is based on a French project aimed at studying the integration processes of dynamic geometry at primary school and the beginning of middle school.

The examination of Computer Algebra Systems (CAS) integration into university-level mathematics Teaching

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Abstract. Although the first ICMI study was almost exclusively concerned with the integration of technology into university-level mathematics, there has been little focus on this phase of education as technology-related research has become dominated by school-level studies. Computer Algebra Systems have quietly become an integral component of university-level mathematics, but little is known about the extent of CAS use and the factors influencing its integration into university curricula. School-level studies suggest that beyond the availability of technology, teachers' conceptions and cultural elements are key factors in technology integration into mathematics teaching and learning. In this proposal I report on an ongoing project and summarize results of the first phase of this study, which is based on interviews and observations of 22 mathematicians in three countries, Hungary, UK, and US. In addition, I outline the development of the secondphase in which a questionnaire will be sent to a sample of 3500 mathematicians in the participating countries to investigate the extent of current CAS use and to examine factors influencing CAS integration into university-level mathematics education. My research contributes to the ICMI-17 by considering cultural diversity, reflecting on actual uses of technology and addressing potential impact of CAS upon mathematics teaching and learning in universities.

Developing Learning and Assessment Tasks in a Dynamic Geometry Environment

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Abstract. This paper presents the development of manipulative tasks in a dynamic geometry environment as a tool for learning and assessment in geometry. In a research study, groups of junior secondary students were asked to manipulate dynamic geometry figures, in the form of Java applets, by dragging movable points to create particular configurations satisfying specified conditions. The tasks are designed in such a way that students are expected to easily make use of learnt knowledge in school geometry to produce the required results. They had to consider real-time measurements provided and constraints on the variation of the figures. As part of design of the tool, students' results of dragging can be recorded as an image and in terms of numerical parameters for later analysis. Students' responses to the tasks were analyzed by first examining quantitatively the variety of configurations produced, followed by clinical interviews probing into the process of students' working on selected tasks. The analysis reveals the complexity of students' interaction with and interpretation of dynamic figures. Based on these results, some major questions are suggested to further explore the nature of dynamic geometry figures and implication of uses of these manipulative tasks in the context of classroom learning and assessment.

Using technology in the teaching of mathematics at the National University of Lesotho

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Instrumental Genesis in Dynamic Geometry Environments

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Abstract. Over the past decade, much research has been done on dynamic geometry software investigating how this virtual environment can change our perception of mathematics and doing mathematics (in particular geometry), in the hope of enriching the pedagogical practices of mathematics teaching/learning. This proposal attempts to employ Vérillon and Rabardel's theoretical construct – instrumental genesis – to study the evolution of utilization schemes by persons engaging in dynamic geometry explorative tasks; a first step in a programme to probe deeper into how geometry is conceptualized and learnt in dynamic geometry environments (DGE). In this study, the theory of variation in the phenomenographic research approach is used as an interpretive tool. In particular, the drag-mode in dynamic geometry is perceived as an artifact, hence an instrument. Consequently, instrumentation/instrumentalization of dragging via functions of variation (contrast, separation, generalization, fusion) and dragging modalities will be a main focus of DGE instrumental genesis. In the proposal, a pair of Hong Kong pre-service mathematics student-teachers' DGE exploration episode is presented and briefly analysed. A possible variational dragging scheme is then proposed for their process of discovery. The studying of the conversation between the two student-teachers during their collaboration in the DGE task further identified a few DGE utterances which illuminate ways to conceptualize discourses in DGE.

Pappus in a Modern Dynamic Geometry: An Honest Way for Deductive Proof

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Abstract. This study shows that dynamic geometry using the "analysis" method systemized by the Greek mathematician Pappus in the 3rd century AD can provide a good learning environment to teach deductive proof for secondary students. Traditionally, in teaching deductive proof the axiomatic or synthesis method to deduce a new result from assumptions has been far more emphasized at the expense of the mathematical discovery process. The method systemized in Euclid's Elements is not an honest way for teaching deductive proof in that it shows only final results by mathematicians and does not help students to appreciate why and how to prove. To improve deductive proof abilities through the analysis method, a dynamic environment in which geometric figures can be easily manipulated are required for an "active justification" to find the heuristics for proof. This paper suggests four phases to solve construction problems in dynamic geometry: First is the understanding phase to recognize problem conditions and goals. Second is the analysis phase to assume what to be solved is done and to find the proof ideas by the analysis method. Third is the synthesis phase to construct a deductive proof as a reversed process of the analysis and finally, the reflection phase to reflect on the problem solving process as a whole.

Cabri 3D: potential, problems and a web-based approach to instrumental genesis

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Abstract. Cabri 3D is a relatively new software which has great potential in the teaching and learning of both 2D and 3D geometry, in enhancing student ability to visualize, in modeling physical structures and motion and in developing new mathematics. In order to facilitate the instrumental genesis of this software an approach based on a web-based integration of text, hypertext, both static and dynamic "pictures" and interactive demos is being developed. This approach may well be useful with other applications.

Dynamic statistical software: How are learners using it to conduct data-based investigations?

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Abstract. Bakker (2002) identified two categories of learning software in mathematics: landscape-type software and route-type software. Route-type software was designed to guide learners through a hypothetical learning trajectory with a fairly fixed destination. Alternatively, landscape-type software is designed to support learners in conducting open-ended investigations. The use of these dynamic software tools for the learning of mathematics and statistics has gained increasing prominence in schools because of its ability to support multiple purposes defined by the user rather than the software. Little is known, however, about the diversity of approaches in which learners use these software packages to conduct investigations. This paper reports on a study of eighteen prospective secondary mathematics and science teachers' approaches to conducting a statistical investigation using the dynamic data analysis software Fathom™ (Finzer, 2001). Three distinct approaches were identified by the research-Wonderers, Wanderers, and Answerers-each with measurable differences in their approach. This paper describes qualitative and quantitative differences in these approaches as well as their potential epistemological roots.

New artefacts and the mediation of mathematical meanings

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Abstract. The paper proposes a theoretical reflection, based on a long-term research project. The aim is that of presenting a Vygotskian perspective for interpreting the functioning of new technical tools within the theoretical framework of social construction of mathematical knowledge. Our study hasdeveloped the relationship between a general hypothesis, concerning the teaching and learning process mediated by artefacts, and specific hypotheses concerning the semiotic potential of specific computational tools. The original notion of semiotic mediation has been elaborated in order to become a theoretical construct both inspiring the design of the teaching experiments and guiding the analysis of the collected data, according to the methodology of research for innovation. The discussion proposed aims to situate the notion of semiotic mediation in relation to other theoretical constructs, in particular, to the notion of instrument and instrumental genesis, as introduced by Rabardel and now developed in the field of mathematics education.

Theoretical Approaches to Learning with Digital Technologies

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Changing mathematical "Vorstellungen" by the use of digital technologies

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Abstract. The paper will reflect the process of learning and understanding mathematics when working with calculators or computers. How do we succeed in developing powerful mental representations, which in German we call "Vorstellungen"? We distinguish two types of Vorstellungen, but the traditional kind of teaching mathematics gives strong emphasis only to one of them, to a reflective, logical and analytical thinking. Most teachers or students or even researchers in mathematics often are unaware of their spontaneous and intuitive Vorstellungen. But only the interaction of both types, the interference of "reflective" Vorstellungen with "intuitive" Vorstellungen, develops powerful mental concepts, procepts, frames, micro worlds, … The use of calculators or computers seems to further this development. Working with a computer we often see a typical guess and test behavior or trials to discover properties or repeating similar key stroke sequences just to make sure …We regard this mainly unconscious behavior as a vehicle to further the development of "intuitive" Vorstellungen and we designed a special teaching method which we called "One-Way-Principle" (abbr. OWP). The OWP is an intermediate step to discover in a set of examples intuitively common properties to move on then to generalize these observations algebraically. Examples will be given.

Teachers & Teaching: Technology and Teacher Education - Some Thoughts

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Abstract. Today as in earlier times, there is much rhetoric about the revolutionary impact on students' learning that will result from brining a new technology into the classroom. In the past, it was the motion picture, or the radio — the usual teaching aids and instructional television. None of these fulfilled expectations. Now, it is the computer that is believed to herald a new era of more effective learning. With respect to the mathematics classroom, computers are claimed to have the potential to change pedagogical approaches radically and to improve students' learning. Traditional classroom teaching methods related to mathematics have been associated with direct teaching, black-board demonstration, use of textbooks or work-books, drill and practice activity, homework and so on — a positivistic, behaviourist model. Teachers who generally teach mathematics this way will most likely use technology similarly. But this traditional classroom and teaching techniques are creating an environment that tend to undermine higher order learning skills, such as creativity, independent thought, inquiry and innovation. It is fundamental to our homogeneous medium for learning that we allow others to tell us what to learn, how to learn and even why we are learning. These mean pupils are being deprived of the scientific approach of teaching — learning systems being the generation of this technological era. Basic differences in the new evolving paradigm will be put the learner in charge. To create such an environment, it is necessary to introduce new technologies like computers, websites on the Internet and DVDs in classroom teaching. So, the objective of this paper is to discuss how the would-be teachers and teachers can be oriented with the use of new technology. What kind of programme should be arranged for the trainees in teacher education courses; to familiarise them with the uses and importance of these technologies? The importance of a mathematics laboratory will also be discussed in this context.

Evolution for a revolution: professional development for mathematics Teachers using interactive whiteboard technology

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Abstract. The interactive whiteboard (IAW) is a presentation technology currently being used extensively in mathematics lessons in England. A growing research base shows that although use of the IAW initially improves pupil motivation it need not necessarily improve teaching and learning. It is suggested that to maximise impact teachers need to move through 3 stages to that called 'enhanced interactive' where thinking and pedagogy change. At this stage lessons have become more interactive and involve more discussion and pupil activity. However professional development is required to move teachers most rapidly to this stage. Based on observations of over 100 mathematics lessons, discussions with teachers and pupil surveys we believe that there is value to be gained by considering the role of gesture as mathematics teachers use IAWs. We also note that where the IAW has been fully exploited there appears to be a dynamic between activities at the IAW, on the pupil's desk and, we contend, 'in the pupil's head'. Finally we suggest that in order for a revolution in teaching and learning using an IAW there needs to be an investment in professional development to enhance reflective practice and to support pedagogic change.

Teachers, technology and cultural diversity

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Abstract. This paper addresses secondary teachers using technology. It considers cultural matters and offers a cultural account. This account is not a model or a theory but a consideration of cultural factors in teachers' use of technology. Different cultures need not be 'far way' and cultural differences within a locality are recognised. Artefacts are considered as fundamental constituents of culture. Artefacts include hand tools and modes of action of using such tools such as beliefs and classroom norms. Pedagogy is viewed as a cultural undertaking. A review of literature suggests that many papers on using technology are 'acultural'. A set of papers is introduced that are considered relevant to building a cultural account. Constructs from these papers include teachers' routines, establishing a dialogue with teachers, teacher privileging, the software of the teacher, motives and goals, emergent goals, ergonomic and anthropological approaches (including orchestration and epistemic and pragmatic values ascribed to techniques) and situated abstractions. These constructs are used to suggest both a cultural account of teachers using technology and ways of working with teachers from other cultures. Mutual respect for teachers from other cultures is emphasised. An end-note considers differences between primary, secondary and university teachers.

Developing Interactive Learning Environments that can be used by all the classes having access to computers. The case of Aplusix for algebra.

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Abstract. Our research team has developed and experimented software for the learning of algebra, named Aplusix, with the idea of being usable and useful for all the classes having access to computers, and of helping teachers to teach the curriculum. In this paper, we list 19 principles that we consider relevant to this goal and we briefly describe the Aplusix system. This system is distributed in France since early 2005 and will be distributed in many countries from 2006. It has proven to be efficient (students learn) and to facilitate the teacher's work.

Curricolar Innovation: An Example Of A Learning Environment Integrated With Technology1

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Astract: An important question in considering the introduction of ewtechnologies inmathematics curricola is that of their effectiveness in enhancing (or damaging) the real capabilities of students. To answer this question the paper sketches a theoretical framework, which frames the new technologies for mathematics as representational infrastructures: as such, they are analysed both as cultural semiotic systems and ascognitive energizers. The two concepts allow to define suitable adequacy criteria for testing the new technologies in the classroom. A teaching-learning environment integrated with technology is described as a concrete realisation of a technologicaloriented Italian curriculum. An example of how learning can happen in this environment is described and a few final comments are drawn with respect to some questions asked in the Discussion Document of ICMI Study 17.

The challenge of teaching and learning math online

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A Case Study Of Developing Students' Ability To Design Algorithm in Logo Environment

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Abstract. The algorithmic idea has been a kind of necessary mathematics quality for modern people in this information society. In China the algorithm was represented fully as one of the new mathematics contents in the secondary level for the first time when The Standards of Mathematics Curriculum for the Senior High School was promulgated in 2003, so the research about the teaching of algorithm undoubtedly has its practical implications for mathematics education. In this paper, with the conceptual framework of The Mathematics Task Framework as the research tool, an algorithmic teaching case based on LOGO software was introduced in detail, and data including observations, interviews and worksheets were collected, then the case was analyzed, and the results showed that the teaching of algorithm is feasible and effective in the LOGO environment. In the last, some beneficial implications about the instructional design of algorithm were discussed.

Building up the notion of Dependence Relationship between Variables: A case study with 10 to 12-year old students working with Math Worlds

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Abstract. This paper reports the results from a study with 10 to 12-year old students working on activities involving various functional representations (graphs, tables, and numerical relationships) in a motion phenomena simulation environment such Math Worlds. Results from the study suggest that pupils that have not been received formal instruction in algebra symbolism are able to evolve towards a better understanding of functional relationships, when working with a variety of representation systems. Duval's registers theory was used for activity design and data analysis. This study is part of a broader project entitled Enseñanza de las Matemáticas con Tecnología (EMAT) (Teaching Mathematics with Technology), which was developed by the Mexican ministry of education at the end of the 90s (Rojano, T., 2003).

Mathematics Revisited and Reinvigorated

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Abstract. Despite enormous changes in technology over the past twenty years, and numerous changes in the UK curriculum, and elsewhere, the content of school mathematics remains very recognisably the same, notwithstanding dramatic changes in the world's modus operandi and the need for citizens to deploy a far wider range of mathematical skills than before.

We identify areas where changes in the curriculum could usefully reflect changing uses of mathematics and address some of the negative perceptions of mathematics as boring, irrelevant and inaccessible; and develop this in the context of our current work on reasoning from evidence. Reasoning from multivariate evidence is pervasive in political speeches and in the media, but is largely absent in UK schools. Currently, we do not prepare young people adequately to understand important social debates, decision-making under uncertainty in a business environment, nor to make informed decisions about their personal well-being.

Two strands of work will be described. The first presents evidence that students can work effectively with multivariate data if they are supported appropriately with good computer interfaces. Second, current work with teachers of mathematics, citizenship, and geography on curriculum materials to develop skills in reasoning from evidence will be reported.

On the role and aim of digital technologies for mathematical learning: experiences and reflections derived from the implementation of computational technologies in Mexican mathematics classrooms

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Abstract: In this paper we reflect, based on the Mexican experience of massive implementation of digital technologies in "real-world" mathematics classrooms, on the role and aim of these tools for mathematical learning. The experience in our country has yielded inconsistent results and the main aim of improved mathematical learning appears to not have been achieved. There have been some positive results (e.g. students' better attitudes and increase of enthusiasm, of motivation, of class participation; the possibility of formulating and proving conjectures and of analysing particular cases that can lead to generalizations) but many factors not present in laboratory settings come into play (from teachers' abilities to administrative difficulties), when attempting a massive implementation such as this one, "out in the real world". Furthermore, the experience has led us to readdress certain questions: a) What is it that students are learning when using new technological tools?; b) What kind of mathematics skills are they actually developing; c) What mathematics do we actually want students to learn with these technologies?; d) Can we put together the learning that does or can take place with the use of these tools, with the learning of what we usually consider as formal basic mathematical knowledge?

Assessment within computer algebra rich learning environments

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Abstract. This paper considers the design of learning environments and curricular, with a particular focus on automatic assessment. Mainstream computer algebra systems (CAS) are currently being used to support assessment, particularly in higher education. For example, the CAS can establish the algebraic equivalence of the student's and teacher's answers. This application of CAS is quite different from the traditional use, which is to model in an exploratory manner rather advanced mathematical ideas. While mainstream CAS have been used successfully for this application for the last five years, this paper examines the affordances and constraints of using CAS in this way. By using CAS-supported assessment it is possible to use openended questions which are traditionally difficult to assess, but which the educational literature suggests can be pedagogically valuable. In assessing an answer to such a question the CAS is used to establish various mathematical properties of the student's response. To focus this paper we concentrate exclusively on the assessment function, while bearing in mind the place of assessment in learning cycles and online learning environments.

Students' Development of Mathematical Practices Based on the Use of Computational Technologies

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Abstract. We document and discuss themes and aspects of mathematical practice that appear relevant during the development and implementation of activities associated with a research project whose aim is to analyze students ways of reasoning that emerge in problem solving classes that promote the use of diverse computational tools. In particular, we focus on identifying (i) the types of questions and conjectures, including arguments
to support them, that students exhibit as a result of using dynamic software, (ii) the students' construction of mathematical relationships that come out from examining dynamic geometric configurations that are formed by simple mathematical objects, and (iii) the curriculum changes that we need to think of in order to validate and promote mathematical practices that favor the use of digital technologies.

Using visual microworlds in teaching mathematics of computation in primary and secondary schools

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Abstract. The most rapidly growing branch of mathematics is mathematics of computation. Today it deals with modern information processing as well as with human reasoning and formal acting. Comparatively slow it appears in secondary school curricula. It is not evident that computers can effectively support learning in this field, but it happened that many key topics of it have been visualized (structural programming, parallel processing, interpretation of logical formulas, etc). The visualization is of two kinds: 'one-to-one', where all objects and processes of mathematical reality are represented on a computer screen, with the only limitations being the object's size and process time, and 'specialized', where specific objects and processes are represented, but this is enough to form general skills of students applicable for all problems of the topic. The major challenge here can be summarized in one word: 'integration'.

Teaching with technology: complexity theory as a lens for reflecting on practice

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Abstract. The main thesis of an article by Davis and Simmt (2003) is that "mathematics classes are adaptive and self-organizing complex systems". Several years ago I examined three technology experiences in light of that thesis, to determine how software, organization, and task impact the blossoming of a complex learning system in the lab-classroom. Since that time I have continued to think about the implications of these ideas in the broader context of implementing, and helping preservice teachers implement, technology in teaching mathematics.
Complexity theory, as applied to education, is a relatively new theoretical framework; however, I believe that it is very appropriate. Based originally on biological models, it offers a perspective from which to examine multiple intertwining relationships, emergence of new ideas from seemingly insignificant events, the creation of unexpected connections, and the development of student understandings that are more than the sum of the parts. In this paper, in light of some ideas from complexity theory, I reflect on my own teaching experiences with technology, and the consequences for my research.

Distance Learning: Mathematical Learning Opportunities for Rural Schools in the United States

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Abstract. Much has been written about technology in the mathematics classroom,in the computer lab, and in students' homes. Such technology includes calculators, SmartBoards™, computers, Internet access, VCR or DVD recorders or players, digital cameras, computer projection apparatus, and other technological solutions to particular teaching and learning needs.Many schools, especially those in remote, often impoverished locales,cannot provide such a cornucopia of goods and services, but there is one technological resource that can provide students in almost any location with the very best learning opportunities available anywhere in the world. This technology is known as Distance Learning, and even at its most basic level,any school with Internet access can open new doors of opportunity for its students. When access to interactive video systems can be achieved,Distance Learning can enable those students to become acquainted with world-class mathematicians and scientists.

Geometry Through the Lens of Digital Technology: Design and the case of the non-euclidean turtle

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Abstract. This paper addresses the theme of designing learning environments and curricula with a focus on geometry. It approaches the theme by first analysing role(s) that digital technology plays in learning by considering the multiple meanings of the microworld concept. Highlighting the fundamental role that pedagogy plays in a microworld, the paper proposes a descriptive theoretical framework derived from Activity Theory to capture those meanings. After discussing the close epistemological relationship between technology and the logical structure of geometries, the paper compares the differences between Euclidean dynamic geometry environments and turtle geometry, and their implications for school curricula. Finally two principles for designing digitally-based environments for geometry are illustrated in the case of non-Euclidean turtle geometry: learner-centred development of tools and activities that mediate understanding in specific geometries, and the use of an iterative design process.

Dynamical Geometry Environments: Instruments for Teaching and Learning Mathematics

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Abstract. Informed by experiments and experience with Dynamical Geometry Environments ("DGE"), the paper elaborates on changes, which are linked to the use of DGE. DGEs allow breaking out of the narrow confines of Euclidean Geometry – best illustrated by the use of the dragmode to introduce movement into static Euclidean Geometry. DGEs offer ways of teaching and learning Geometry, which are not available in a traditional paper-and-pencil environment. The macro-functionality of DGEs appears to be an excellent possibility of structuring the material and cognitive representation of a construction process. On the other hand, the explorative potential of DGE often implies a "de-goaling" from the initial task. Worksheets and the intervention of the teacher are suggested to cope with these difficulties of learning with the help of DGEs. An excursion additionally shows that some of the design decisions within (Geometry) software are constrained by unavoidable mathematical necessities – with implications for pedagogical and cognitive (dis)advantages. Following an 'instrumental genesis' approach, design decisions should be made after close inspection of the ways the users 'instrumentalize' the software. Some of the findings on DGE can obviously be generalized to other types of mathematical software available or forthcoming in the near future.

Solving Equations in a Spreadsheet Environment

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Abstract. The use of spreadsheets in a beginning algebra course is considered traditionally with regard to their potential to promote generational activities. However, much less is known about their possible use to construct and solve equations. The overall purpose of this paper is to consider the potential of spreadsheets to enhance conceptual understanding of equations and their solutions. For this purpose, we analyzed the work of beginning algebra students with an activity that required algebraic modeling, solving equations, and interpreting results that were obtained as an Excel output. As a result, we recommend expanding the traditional use of spreadsheets from mathematical investigations of variations and patterns to include a conceptual understanding of algebraic relations and transformations as well.

Developing resources for teaching and learning mathematics with digital technologies in Enciclomedia, a national project

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Abstract. Encilomedia is a Mexican national project that intends to complement already existing materials for primary school classrooms with computer programmes and teaching resources that are to be used with an interactive whiteboard. In this paper we report on the process of development of resources for teaching and learning mathematics with Enciclomedia. Our approach is guided by an enactivist theoretical perspective and methodology (Maturana and Varela 1992; Varela, 1999; Reid, 1996) which invites us to consider our work as a learning process in which we continuously refine the resources we develop. Our work includes analysing existing teaching materials, having conversations with teachers, reading the literature and doing research with the purpose of identifying the kinds of activities the new programmes foster in the classrooms. Throughout this work, we discuss the different aspects of this process of development of resources. We illustrate our way of working through three different mathematical themes: fractions, probability and area. We have found that working with the multiple perspectives which are prevalent in our group has enriched the production of resources. Finally, the circular nature of the process helps us in refining our methods and in questioning our assumptions; that is, in developing our own learning and making our educational initiatives more effective.

Gender and socio-economic issues in the use of digital technologies in mathematics

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Abstract. This paper has been prepared to address the issues and questions of the theme 'access, equity and socio-cultural issues'. Findings from two studies are reported. In the first study gender issues in mathematical learning environments when computers were used were investigated. In the second effective practices for teaching disadvantaged or marginalised students with digital technology are canvassed. Teaching for equity and social justice in the digital age is complex. Teachers need to be aware that their beliefs and classroom practices may exacerbate gender and cultural inequalities in mathematics learning. Approaches that are consistent with social-constructivist and democratic theories need further investigation.

Online homework, quizzes and tests enhanced with an equation editor and tools for collaboration

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Use of Graphing Calculators in Pre-university Further Mathematics Curriculum

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Abstract. In Singapore, the use of graphing calculators in the pre-university level Further Mathematics examinations was first permitted in the year 2001. This study examines Further Mathematics students' performance and usage of GC in solving problems on Curve Sketching, Linear Spaces and Statistics. A total of 190 students enrolled in the second year of the two-year pre-university course in Singapore who took Further Mathematics were surveyed on 3 occasions at intervals from March to September 2003.The results obtained seem to suggest that graphing calculator users perform better academically than non-graphing calculator users. Temporal benefits of graphing calculator usage in a timed pencil-and-paper assessment are also alluded to. Further in-depth studies need to be performed to ascertain the factors surrounding graphing calculator usage, such as teacher proficiency and instruction, and a formal teaching scheme that incorporates the use of the graphing calculator on a regular basis needs to be developed and systematically carried out to ascertain the many facets of graphing calculator usage and its potential as a learning and teaching tool at the pre-university level in Singapore.

Challenging Known Transitions: Research of technology supported longterm learning

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Index

F

G

H

I

J

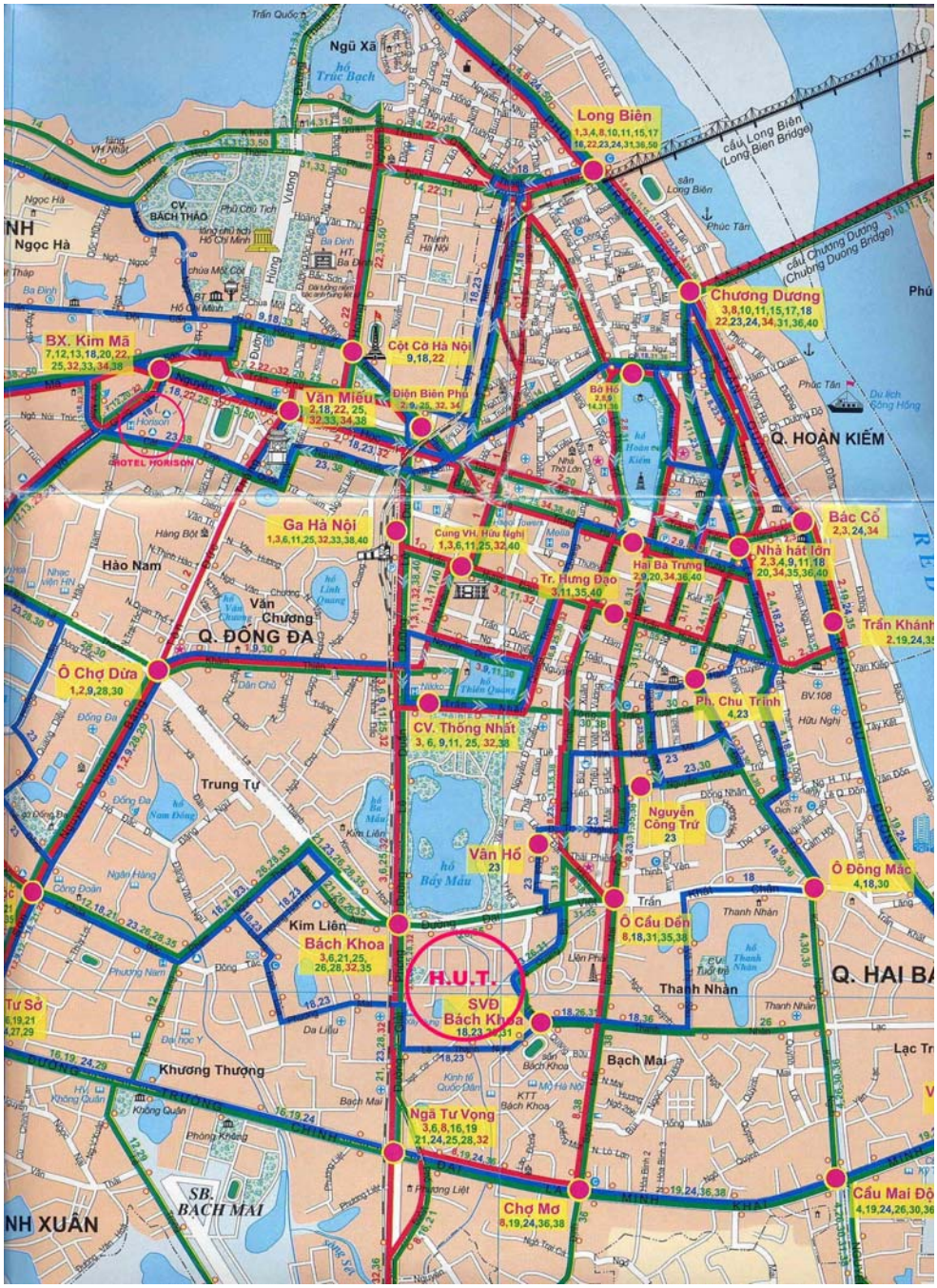
T

u

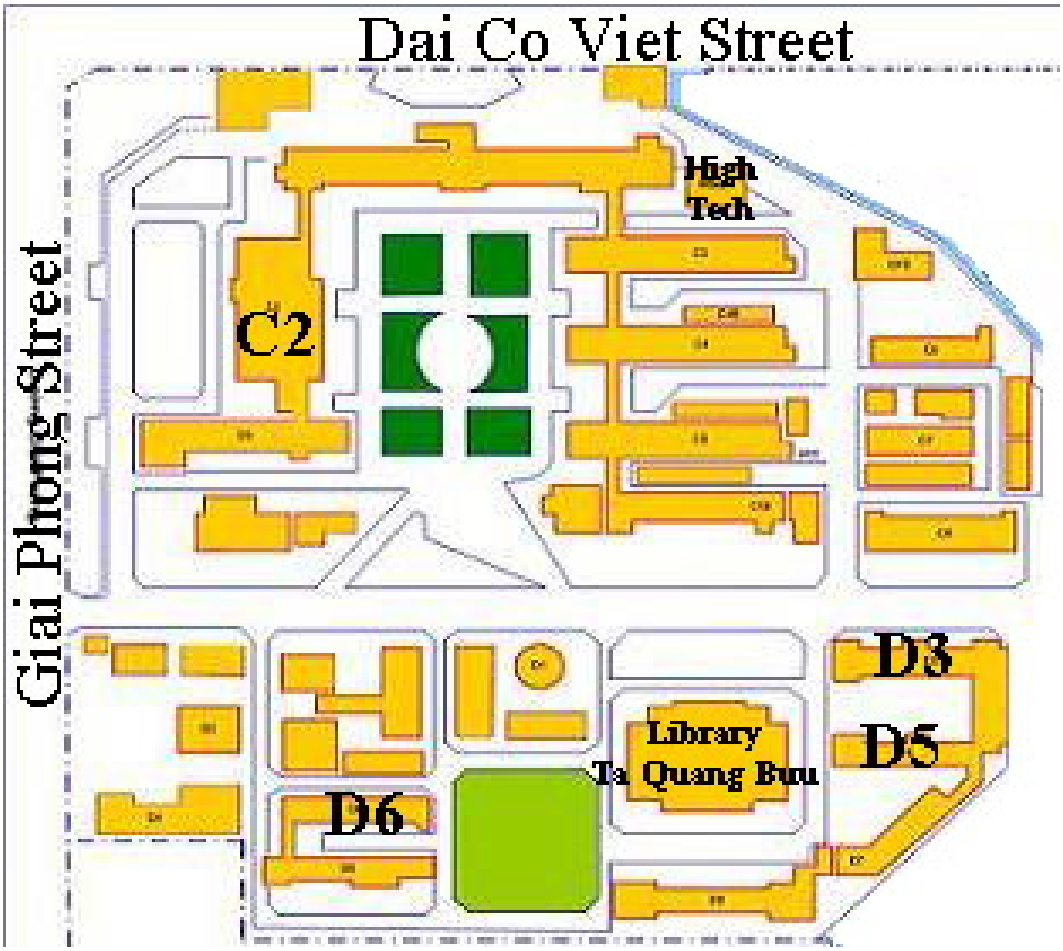
V

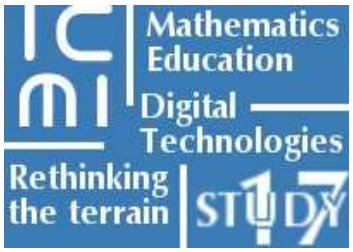
W

Hanoi: Orientation Map



Hanoi University of Technology: Orientation Map





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