



The
Fibonacci
Project

Mathematics, Sciences and ICT

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André Revuz

Bayreuth, First Fibonacci Conference, 21-22 September
2010

An unquestionable reality

The influence of technological advances and computer sciences:

- on scientific practices;
- on research perspectives and agendas in science;
- on the ways scientists communicate inside their own communities and with the outside world.

In mathematics...

- A dramatic change in the means and economy of experimental work, in its visibility and image.
- An enriched vision of the applicability of mathematical models and structures, blurring the traditional frontiers between pure and applied mathematics.
- New resources and tools for communicating about mathematics.

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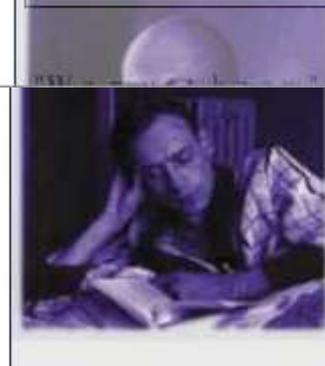
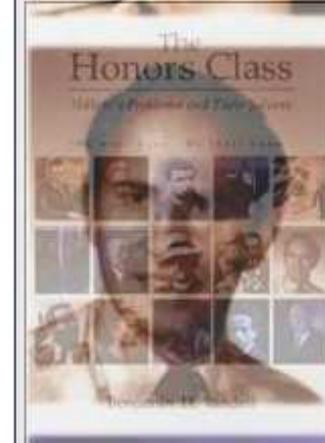
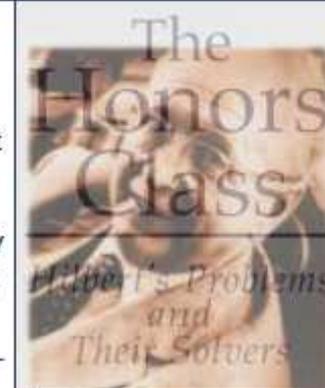
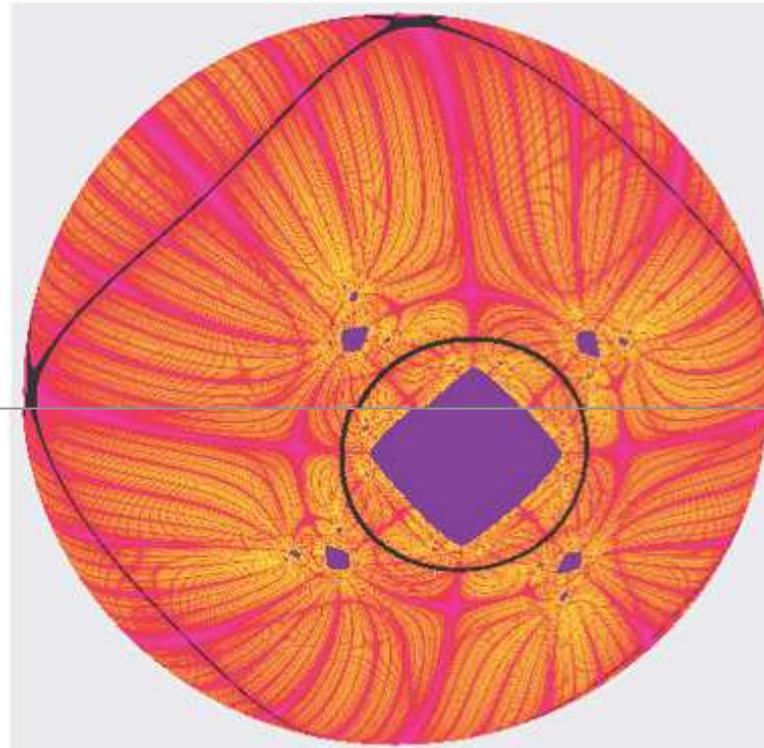
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Cassini quartic with $k = 1/8$, but using the map with parameter $a = 2$.
[Bonifant et al. "Elliptic Curves as Attractors in \$P^2\$, Part 1: Dynamics"](#)
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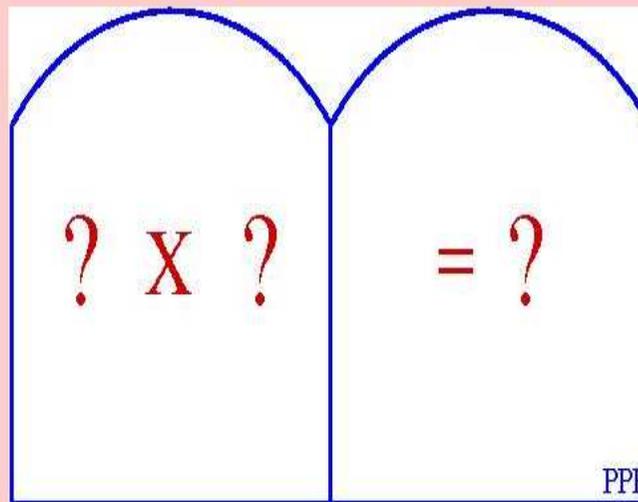
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À la une : Quelle loi pour les tables ?

Le 16 septembre 2010, par [Patrick Popescu-Pampu](#) — [Café des maths](#) — [Piste verte](#)



Est-il encore nécessaire d'apprendre les tables de multiplication à l'âge de l'explosion informatique ? Je discute cela à partir d'affirmations d'Umberto Eco et d'Etienne Ghys.

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On the educational side, the early emergence of....

- The conviction that computer technologies have a strong potential for enhancing sciences and mathematics learning.
- The conviction that these technologies should make easier the desired evolution towards constructivist approaches to teaching and learning (Cornu & Ralston, 1992)

Leading to...

- The development of specific educational artifacts:
 - educational interfaces for supporting the collection and analysis of experimental data in a diversity of scientific domains;
 - simulation tools for compensating experimental limits and exploring the behavior of complex systems;
 - microworlds with among these dynamic geometry.
- But also, the educational use of spreadsheets, statistic packages, and other professional tools for numeric and symbolic computations, for graphical representations...

More than three decades of research and innovation in that area...

- Increased understanding, accumulation of successful experiments (Hoyles & Lagrange, 2010)
- But:
 - until now, a limited and questionable impact on educational systems at large;
 - until now, an unsolved problem: how to efficiently deal with up-scaling issues.
- Can the Fibonacci project overcome these limitations, and especially help ICT use support the dissemination of inquiry-based education in mathematics and science?

The potential offered by contextual changes

- Changes in the technological context with the development of Internet and mobile technology.
- Changes in the institutional context with the increasing attention and support given to large-scale and dissemination projects, capitalization of research, and the development of networks.

The Kaleidoscope Network of Excellence

<http://www.noe-kaleidoscope.org>

The screenshot shows a Mozilla Firefox browser window displaying the website http://www.noe-kaleidoscope.org/telearc/case_studies/. The browser's address bar and search bar are visible at the top. The website header features the tagline "shaping the scientific evolution of Technology Enhanced Learning" and the "kaleidoscope powered by TELEARC" logo. A navigation menu on the left includes links for HOME, ABOUT, NEWS, CASE STUDIES, FOR STAKEHOLDERS, FOR PHD STUDENTS, SCIENTIFIC NETWORKING, and INTRANET. The main content area is titled "Kaleidoscope case studies" and contains two paragraphs of text. The first paragraph states: "To demonstrate how Kaleidoscope researchers work with end users, software developers and business R&D - at home, at work and in education, we present a variety of case studies developed in collaboration with individual and organisational members of the network. The links to these case studies can be selected from the menu to your right." The second paragraph mentions: "We also include a link to case studies collated by the Kaleidoscope Stakeholders Club, who invite you to become a member of their activities whatever your perspective on technology enhanced learning. The Stakeholder Club case studies demonstrate the perspectives of user involvement when developing and using TEL products and services, and look at TEL research in more depth than the case studies which are presented here." Below the text, there is a link for "Computer Supported Inquiry Learning: what is it all about?" and another for "The need for new approaches to evaluation in university courses". A sidebar on the right lists various case studies, including "Computer Supported Inquiry Learning: What is it?", "Centre for Excellence for Work-based Learning for Education Professionals: Need for new approaches to evaluation in university courses", "Kaleidoscope Stakeholder's Club Case Studies", "Intermedia: research, researchers and an ex-dean's perspective", "London Knowledge Lab: working with luxury car manufacturers", "Centro Tempo Reale, University of Florence & partners: musical literacy for children", and "MeTAH: Training for orthopaedic surgeons". A small notification box in the bottom right corner reads: "Bienvenue dans VAIO Update ! Cliquez ici pour en savoir plus sur les logiciels et mises à jour de sécurité importants pour votre PC VAIO !".

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Kaleidoscope case studies

To demonstrate how Kaleidoscope researchers work with end users, software developers and business R&D - at home, at work and in education, we present a variety of case studies developed in collaboration with individual and organisational members of the network. The links to these case studies can be selected from the menu to your right.

We also include a link to case studies collated by the Kaleidoscope Stakeholders Club, who invite you to become a member of their activities whatever your perspective on technology enhanced learning. The Stakeholder Club case studies demonstrate the perspectives of user involvement when developing and using TEL products and services, and look at TEL research in more depth than the case studies which are presented here.

For more information on any of these case studies, email Paul Davey: p.davey@joe.ac.uk

Choose case:

Computer Supported Inquiry Learning: what is it all about?

Dr Angelique Dimitracopoulou, Professor at the Aegean University (Greece), and member of the Kaleidoscope Computer Supported Inquiry Learning Special Interest Group, speaks on the related domain: what the research has offered and how education should profit from it.

The need for new approaches to evaluation in university courses

University teaching staff must understand more about the experiences of students who return to university for postgraduate study and who are expected to learn by communicating in electronic discussion groups. Often these students have had

Case studies

- Home
- Computer Supported Inquiry Learning: What is it?
- Centre for Excellence for Work-based Learning for Education Professionals: Need for new approaches to evaluation in university courses
- Kaleidoscope Stakeholder's Club Case Studies
- Intermedia: research, researchers and an ex-dean's perspective
- London Knowledge Lab: working with luxury car manufacturers
- Centro Tempo Reale, University of Florence & partners: musical literacy for children
- MeTAH: Training for orthopaedic surgeons

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The Kaleidoscope Network of Excellence

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Case studies:

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 - Kaleidoscope Stakeholder's Club Case Studies
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 - Centro Tempo Reale, University of Florence & partners: musical literacy for children
 - MeTAH: Training for orthopaedic surgeons
 - MeTAH: Algebra for school children
 - MeTAH: Planning chemistry experiments
 - KMRC: TEL research in German hospitals
 - KMRC: Scripting collaborative interaction - what it is; what it does
 - KMRC: The Excel project

Main Content:

Kaleidoscope > Telearc > Case_studies

Dr Angelique Dimitrakopoulou, Professor of Aegean University (GR), and member of the Coordination group of Computer Supported Inquiry Learning, Special Interest Group, established in Kaleidoscope NoE, speaks on the related domain: what the research has offered and how education should profit from it.

So, what is Computer Supported Inquiry Learning?

Inquiry learning is an active approach to learning that involves exploration, and questioning. In order to answer questions students explore domains, pose questions, design experiments, collect data or build models to test ideas in search of new knowledge and understanding. The importance of self directed inquiry learning was pointed out from the pedagogues decades ago, in the beginning of the previous century. Actually, technology enables us to design learning environments that first of all allow the exploration and modelling of phenomena that are often not immediately visible, or do not have a visible representative. But, what is even more significant for the learning process, these computer supported inquiry learning environments are designed with the purpose of effectively supporting students during the inquiry learning process.

Software Interface Screenshot:

COLLAB - Sarah's last experiment, condition 1

Tools: Process coordinator, COLLAB Help, Table, Graph, Tank Level Laboratory

Parameters: Theory, Lab, Meeting, Change floor

Table:

Time	Level in tank (m)	Outflow rate (l/min)	Outflow rate (m/s)	Initial tank level (0.000 m)	Tank diameter (0.200 m)	Floor from tap (0.100 L/min)	Hole diameter (0.000 m)
0.0000	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0010	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0020	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0030	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0040	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0050	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0060	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0070	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0080	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0090	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0100	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0110	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0120	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0130	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0140	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0150	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0160	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0170	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0180	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0190	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000
0.0200	0.0000	0.0000	0.0000	0.0000	0.2000	0.1000	0.0000

Graph: A graph showing the relationship between time and level in tank, with a red curve indicating a decreasing trend.

The ReMath STREP

<http://remath.cti.gr>

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The ReMath Project

Making sense of theory on learning mathematics with digital media

Project Outcomes:

- Six Dynamic Digital Artifacts** in Algebra, Geometry and Mathematics in Science and Geography,
- 13 Pedagogical Plans** addressed to **Researchers** showing how theory drives practice,
- The same **13 Pedagogical Plans** addressed to **Teachers** showing the potential of using digital media for mathematical teaching and learning – each one in English, French, Italian and Greek,
- An academic description of **cross-case studies** of classroom activity emerging from the implementation of the Pedagogical Plans,
- An academic description of how the **above experience** can help in making sense of theory in **learning mathematics with digital media**.

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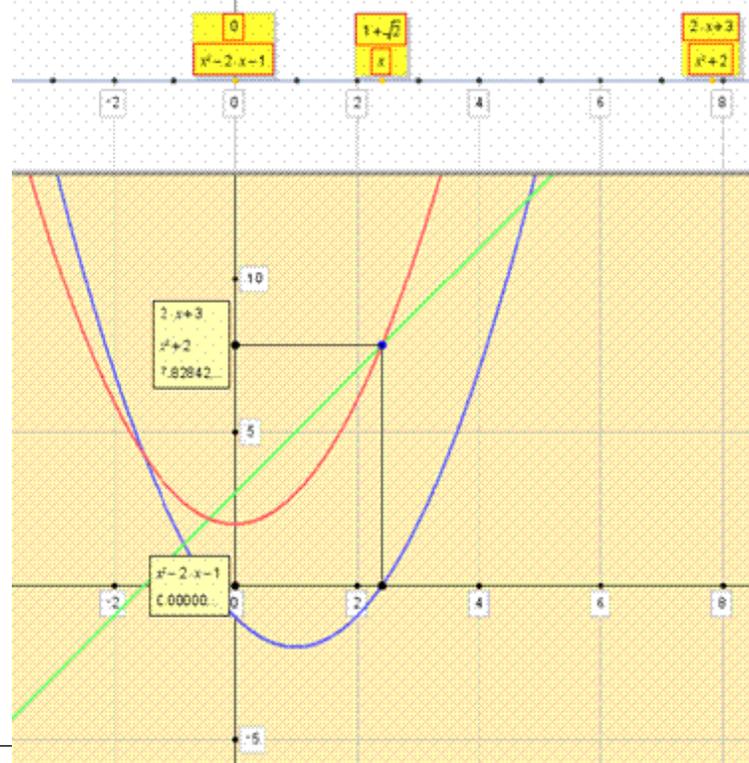
++ En ligne

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This screenshot shows a dynamic geometry software interface. On the left, a coordinate plane displays a parabola with its vertex at the origin. A red line is drawn across the map of the Philippines in the background. The software includes a toolbar at the top and a panel on the right with various mathematical tools and options.

This screenshot shows a 3D geometry software interface. It features a yellow cone and a red cone on a grid. The software includes a toolbar at the top and a panel on the right with various mathematical tools and options.

This screenshot shows the Aplusix software interface. The top part displays algebraic calculations: $(x-3) \times (2x+5) - 2(x-3)$ and $(x-3) \times (2x+5) - 2(x-3)$. Below the calculations, there are two geometric objects: a yellow square and a blue oval. The interface includes a toolbar at the top and a panel on the right with various mathematical tools and options.



The potential offered by contextual changes

- Changes in the technological context.
- Changes in the institutional context.

But also:

- Changes in the scientific context at large, and promising evolution of educational perspectives.

Efforts made for capitalizing on research and innovation: the ICMI Studies



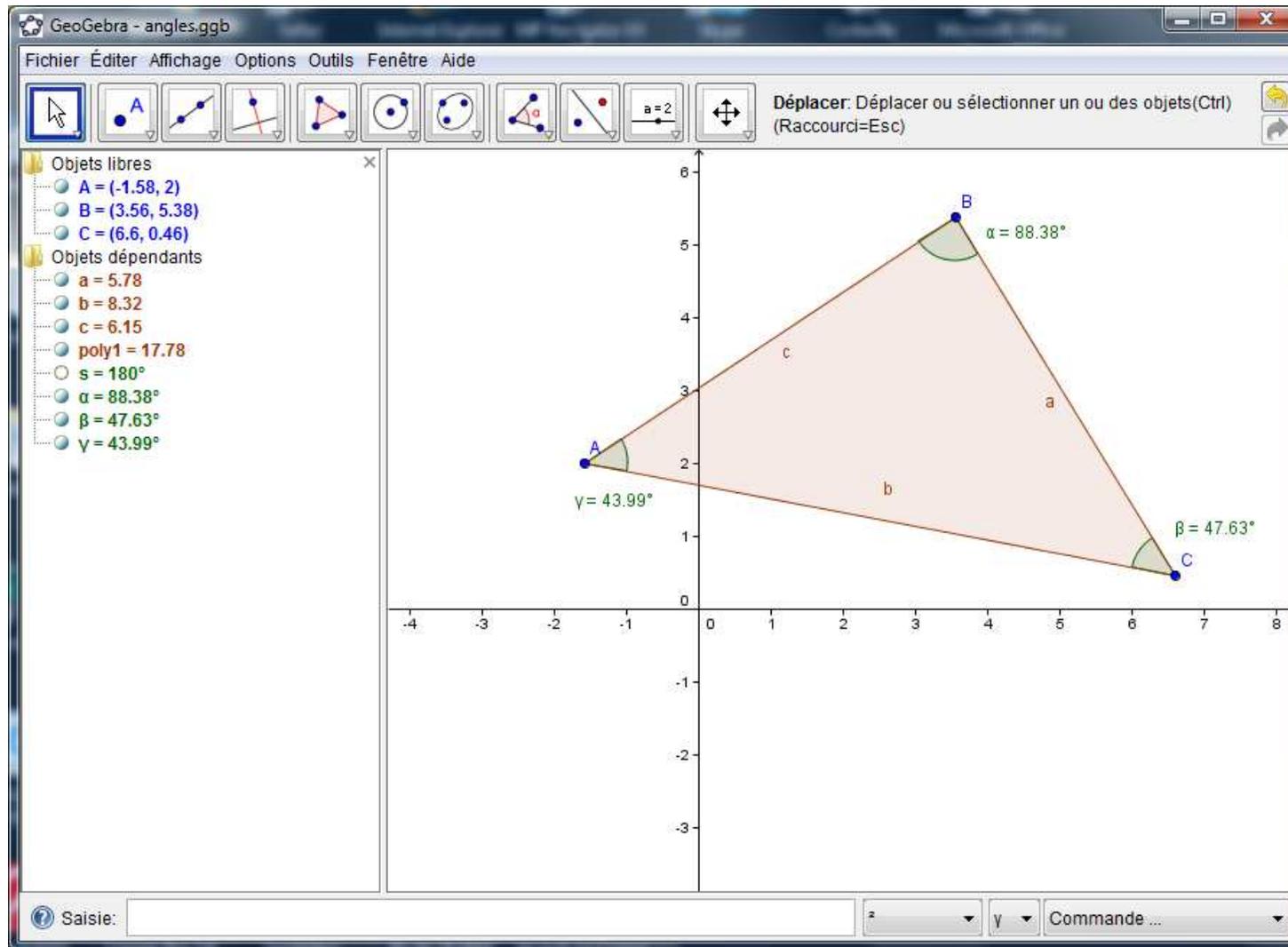
Nevertheless, many challenging issues to face, and among these...

1. The attractiveness of ostensive and pseudo inquiry-based practices.
2. The under-estimation of instrumental issues.
3. The specific ecology of most successful experiments.
4. The diversity of educational cultures and contexts.
5. The connection between maths and sciences.

1. Does ICT use really serves inquiry based practices?

- The attractiveness of ostensive practices in the use of ICT: the emblematic case of interactive whiteboards (Miller & al., 2005).
- The attractiveness of pseudo-inquiry activities as illustrated for instance by:
 - Laborde & al.'s research on the evolution of teachers' scenarios in a three years project with Cabri-géomètre (2001)
 - Haspekian's thesis on spreadsheets (2005).
 - Tapan's thesis on pre-service teacher education in dynamic geometry (2006).

Pseudo-inquiry: the sum of angles in a triangle

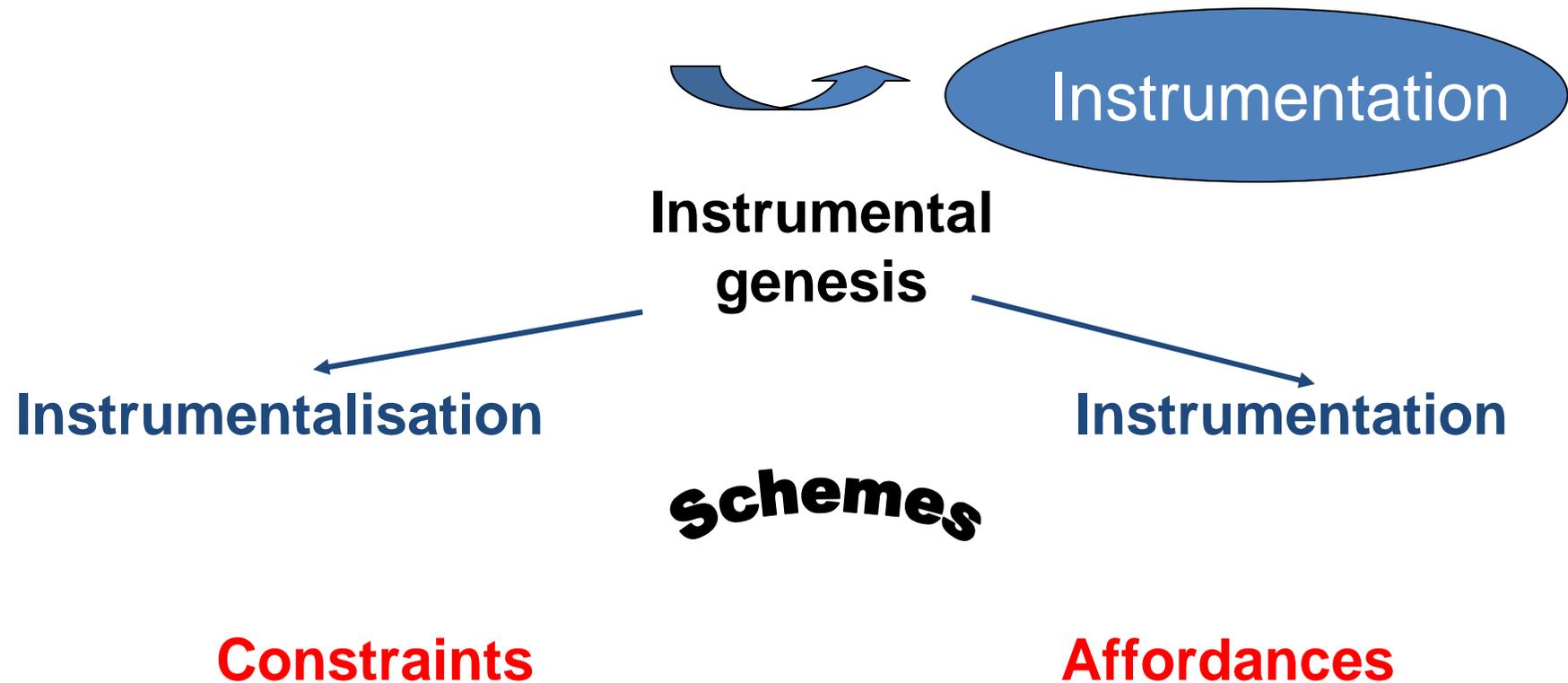


Reflecting on such examples

- The importance of task design, and the attention to be paid to:
 - the quality of initial questions, be these internal to the mathematical field, scientific or coming from the real world;
 - the a-didactic potential offered by the interaction with the « milieu » and the added value of ICT use;
 - the possible sharing of scientific responsibilities between students and teacher, and how it can be optimized;
 - the mediating role of the teacher.
- All questions essential for IBSME that, in fact, goes beyond the specificity of ICT use.

2. The under-estimation of instrumental issues

What is at stake? (Rabardel & Verillon, 1995), (Artigue, 2002)



What impact on inquiry-based practices?

- The fact that inquiry-based processes generally suppose some achievements in terms of instrumental genesis:
 - the paradigmatic case of dragging in dynamic geometry studied in Restrepo's thesis (2008)
- The mixture of technological and mathematical knowledge which is involved in instrumental genesis :
 - the case of instrumental schemes attached to functional representations in graphic calculators or CAS (Guin, Ruthven & Trouche, 2004);
 - the case of copying command, formulas, absolute and relative references when working with spreadsheets (Artigue & Haspekian, 2007).
- The necessity of building resources taking in charge the progression of instrumental genesis, which has been hardly the case up to now.

3. The specific ecology of many successful experiments

- Many experiments, especially at secondary level, are successful because some of the standard constraints have been relaxed: specific allocation of time for projects, multi-disciplinary activities, workshops for voluntary students, out-of-school activities...
- How to combine attention to such crucial but most often episodic experiences with the necessary attention to the development of an inquiry-based culture permeating all facets of mathematics and sciences education, taking into account curricular expectations, and the necessary progression of scientific knowledge?
- How to think and instrument a vision of dynamic realistic evolution towards such a culture ?

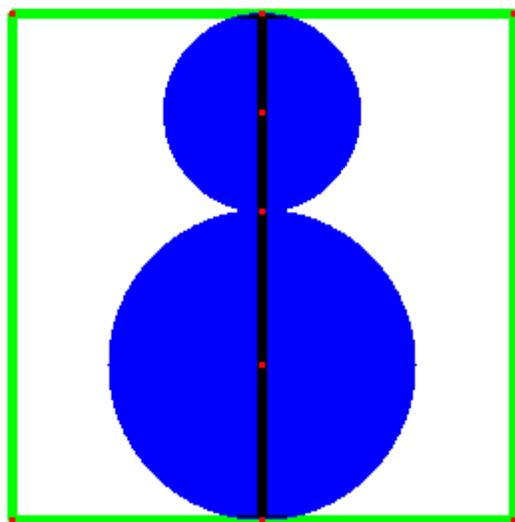
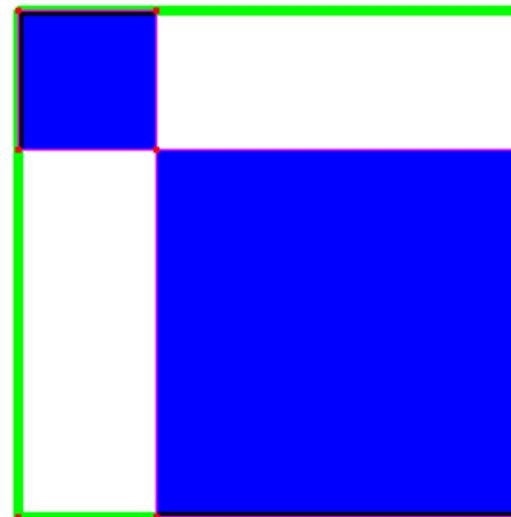
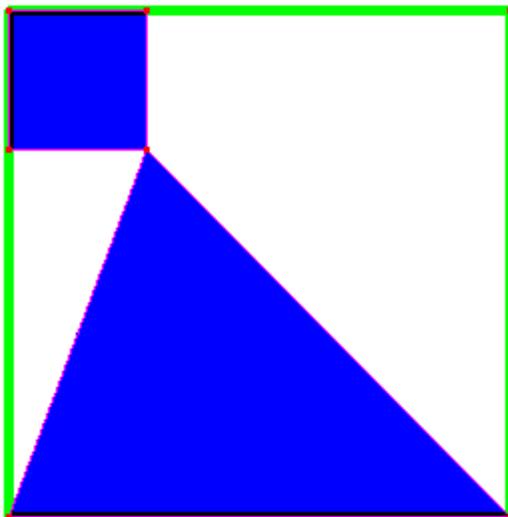
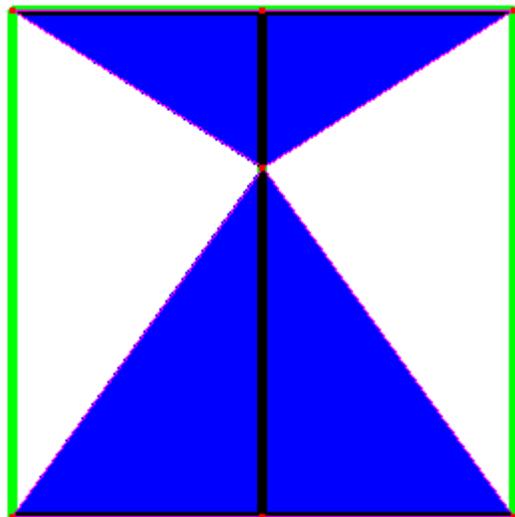
~~ANOTHER FACET OF CURRENT INQUIRY-~~ based practices to take into consideration

- The increasing combination of personal or group investigation and the increasing search for information and answers to initial or emerging questions through Internet use.
- The increasing inadequacy of the usual image of the problem solver relying only on his(her) cognitive resources, even when extended to a group of learners working collaboratively.
- The interest of the vision in terms of activity of study and research, and of the associated idea of dialectics between « media and milieu » introduced by Chevallard in the anthropological theory of didactics (2002, 2006) for giving account of current inquiry-based learning practices, and also approaching the new educational needs they generate.

4. The diversity of educational cultures and contexts

- A regional scope for the Fibonacci project: the European Union, but nevertheless a strong diversity of educational cultures and contexts, in terms of equipment, curricular expectations and policies regarding ICT, the respective importance given to their tool and object dimensions...
- The necessity for the Fibonacci project of taking in charge this diversity in its twining and dissemination practices.
- A challenge that I personally meet in the Comenius project EduMatics aiming at the collaborative production of a European course for teacher professional development in the productive integration of ICT.

The Sign family (EduMatics)



- An a priori analysis of the potential of this family for the topic at stake « Functions and modelling ».
- A range of educational scenarios for envisaging adaptation to different curricular goals, students' knowledge, didactic organizations.
- Excerpts from videos and students' productions fostering discussion and work on important issues.

The lack of connection between mathematics and science education

- A problem experienced in many countries, at least at secondary level.
- The difficulty of communication experienced even when specific didactic organizations are supposed to promote such connections, due to the limitations of teacher education.
- The importance of having teachers experience themselves the power of such connections with their scientific background.
- The experience of the modeling course in the master program for teacher educators in my university.

And, to conclude

- My personal conviction that a project such as Fibonacci can make a difference, particularly due to the experience and knowledge on which it can rely, the expertise it gathers and the original and progressive strategy it has planned for dissemination.
- My conviction that ICT is crucial for the success of this enterprise at different levels, both for supporting the ecology of inquiry-based practices, and the global ecology of the project, supporting its values of collaboration and solidarity.
- But also my conviction that, if we want to succeed where so many have failed, we must seriously take into account the lessons of these failures, and substantially progress on many challenging issues. For that purpose, we need to create original combinations of research and design.

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