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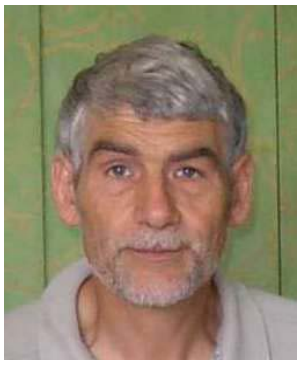
Plenary Panel: Design for transformative practices

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.*

Jean Baptiste Lagrange



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 panelists will each present their specific vision and experience before responding to interactions from conference delegates.

I will chair the panel and, if necessary, bring complementary views, especially in the area of symbolic computation.

Douglas Butler

1. A forward thinking school curriculum should be aiming to assume that school pupils will enjoy the same working environment as is now the norm in the world of work for which they are being prepared: ie fast web connected computing available to all. With the $100 laptop nearly a reality this is not out of the question.
2. In the world of mathematics education I would like to see #1 being put to imaginative use in bringing the real world more into the classroom, to emphasise the relevant of the subject, and increase motivational levels.
3. Appropriate hi-resolution software such as Cabri 3D, GSP and Autograph to be assumed. I'll leave GSP and Cabri to my colleagues on the panel. I will present some ideas of how Autograph can be used to make some traditionally difficult topics appear more straightforward, especially in the realms of calculus, 2D and 3D vectors and statistics.
4. I would like to extend this to discuss some important mathematics topics that should be re-introduced to mainstream post-16 teaching, now that software is available to make them more accessible. The list will include differential equations (for modelling), 3D coordinate geometry (eg to relate to animations in the movies) and large data sets.

Michal Yerushalmi

My interest is in the mutual relationships between research and development of curriculum and technological mediators.

Obviously curriculum should be redesigned when we think about uses of technological tools in a way that will conceptually change teaching and learning practices.

New curriculum design should be driven by ideas on mathematical meaning and not by new tools. However, often we change practices and even a whole curriculum (by curriculum I mean the sequence of the content and the norms and practices of learning and teaching) because we acknowledge the fact that a new tool or new technology can change epistemology and/or cognitive hierarchies and therefore may help to encounter known challenges. My experience is that development of software and of curriculum should go hand by hand.

I will attempt to point on research issues that I find most helpful in supporting R&D cycles and will exemplify the need and the impact of each by pointing on specific examples of tool design and curriculum development. Of course, research in education has integrative nature and the distinction and categorization I chose are artificial in a way but will help for the organization and focus of the panel.

- Epistemological issues: Should and how do the structure of a tool, the structure of the mathematical concept or field and the structure of the curriculum correspond? e.g. school algebra.
- Semiotic aspects: communicating with mathematical objects and signs, visual signs and interactive diagrams, tangible representations, tools as signs-vehicles
- Cognitive issues related to: Choice of cognitive root, cognitive hierarchies or cognitive discontinuities, problem solving with linked representations, modelling,
- Beyond the individual - Classroom practices: Designing the mediating activities - interactive books, connectivity – hand held and mobile technology.

Nicholas Jackiw

While I agree, in essence, with both Michal and Douglas on the essential interactions between curriculum design and technology, I would like to step away from curricular-design issues (as they relate to technology) and take more of the perspective of materials-design---or even industrial design, or artistic design---in considering the technological artifact itself.

In my presentation I hope to ask:

1. how do the interface- and interaction-designs of a mathematics education technology situate or "figure" its user?
2. and how do they construct or situate the mathematics that technology enables (or facilitates, or accommodates, or accessorizes)?

Answers to the first question clearly inform an educational technology's ultimate relationship to learners; just as answers to the second its relationship to curricula. What dimensions of these design questions are unique to the medium of interactive software design? I will explore these questions from the specific perspective of 20 years' experience designing The Geometer's Sketchpad, where they become: what does Sketchpad itself say about who the user is, who is using Sketchpad? And what is the mathematics that is Sketchpad's Dynamic Geometry?

With respect to the construction of the environment's user, I hope to examine these ideas:

- the role of language (within and in relation to software)

- the role of diagnostics, assessments, and feedback (both positive and negative, as provided by software)

- the role of direct manipulation

With respect to the situation of the software's mathematics, I plan to look at

- the role of dynamism and dynamic response -- the retemporalization of mathematics

- the role of abstraction and generalization -- the detemporalization of mathematics (in Balacheff's sense)

Jean-Marie Laborde

Reading the various contributions we can assume that it is almost a truism now to consider that dynamic educational technology has the power to enhance the learning and teaching of mathematics. In my contribution I would like to stress Dynamic Technology, as in many successful computer environments, going hand in hand with direct manipulation of mathematical objects, often referred to through the term of DragMode. Here DragMode refers to the possibility for the user to change the characteristics of the objects, directly, with a mouse, a stylus, or possibly the finger on interactive whiteboards, and see what changes, and probably more importantly, what does not change.

To my eyes, Direct Manipulation and Dragmode, available today even on mobile technologies, have radically transformed the way people learn and teachers teach. I would like to focus on the specifics of Direct Manipulation and Direct Engagement in a 3D geometry environment aimed to support math activities.

With regard to Direct Manipulation and Direct Engagement, I will show that creating a usable 3D environment is not simply introducing internally an additional coordinate into a 2D interactive geometry environment, as some people might think or have thought. Obviously the reality is more complex... An evidence of the additional complexity added by a new coordinate is the comparison between the geometry on a line i.e. of the real numbers, and the 2D Euclidean geometry!