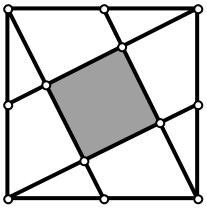
Report of working group 5: Making it interesting

Chairs: Nathalie Sinclair (nathsinc@educ.queensu.ca)
Sandy DiLena (sandy.dilena@tel.tdsb.on.ca)
Christiane Rousseau (rousseac@dms.umontreal.ca)
Yvan Saint-Aubin (saint@dms.umontreal.ca)

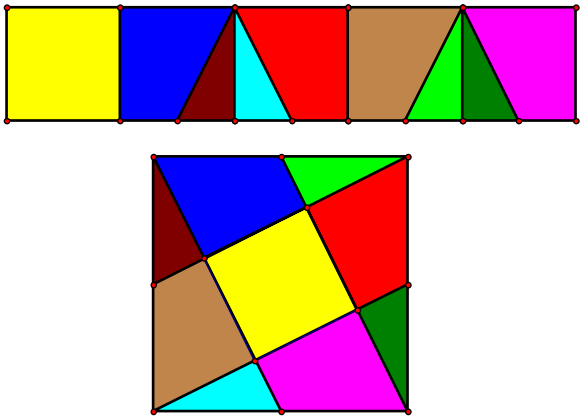
Participants:
Isabelle Blain (isabelle.blain@crsng.ca)
Benoît Brosseau (bbrosseau@sympatico.ca)
Louis Trottier (trottierlo@csdm.qc.ca)
Patrick Moisan (patrick.moisan@fse.ulaval.ca)

Session 1

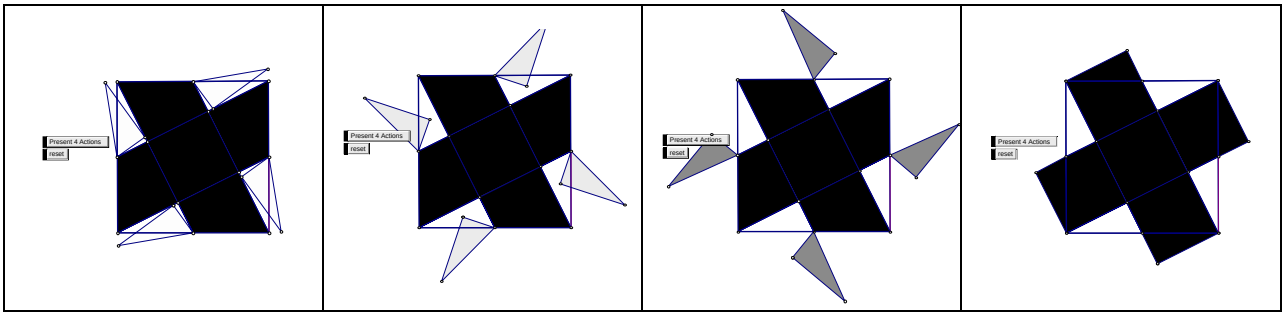


The working group started with a presentation by Nathalie Sinclair on a middle-school activity using *The Geometer's Sketchpad*. In the activity, students are given the "solution" of a problem and asked to use Sketchpad to 'demonstrate' the solution. The solution is that the shaded square is 1/5 the area of the big square.

Although a demonstration does not constitute a proof in this activity, it does include many important elements of a proof in a way that helps students appreciate the role and nature of geometric proofs. The pictures below represent two 'demonstrations' of the solution. Because students have to use Sketchpad to construct and manipulate the mathematical relationships, their demonstrations require the kind of mathematical reasoning that is involved in composing a proof. In addition, students come to appreciate the idea that creating a demonstration means trying to show other people why something is true. In so doing, students bring to their work many of the aesthetic appraisals that mathematicians do when composing proofs, striving to attain perspicuity, efficiency, cleverness, etc.



Demonstration 1: The lower square is decomposed to form five adjacent squares.



Demonstration 2: The four triangles are rotate around to form squares with the trapezoids.

Students doing the activities presented are proud and experience the satisfaction of finishing something. The group all agreed on the fact that it would be interesting to generalize such activities with students of that age. The group also discussed on actions that could be taken so that more teachers do that kind of activities in their classroom. A depository would certainly be helpful although not sufficient. In particular it seems a necessary condition that teachers be trained with Sketchpad and also that they experience themselves the pleasure and satisfaction of finishing something.

Session 2

The second session of the working group started with a presentation by Sandy DiLena. Sandy is working with elementary and secondary teachers in professional development. Sandy presented activities involving probability and statistics. Here one encounters a lot of situations that are not in line with one's intuition. A message through the activities is that our intuition can lead us to make errors. So, mathematical rigour needs to be added to intuition. A second message from the activities is that mathematics has become an experimental discipline as are other sciences. A third message is that this is exciting: students are having "I love Mathematics Experiences". A fourth message is that students learn to ask questions through such activities. Indeed, simulations allow the derivation of the rules governing probability games. The working group then discussed possible actions to take which would build learning groups. One action is the development of videos of good activities for students from kindergarten to graduation.

We discussed the possibility of developing mathematics labs. For instance, labs could be developed using Excel to study functions. Labs could start with data coming from mathematics or science and having students identify mathematical functions to model the data. Once again there is a need for good depositories.

Session 3

The last session started with a presentation by Yvan Saint-Aubin and Christiane Rousseau of their course "Mathématiques et technologie" for preservice secondary school teachers. An essential purpose of the course is to discover that mathematics play a central role in everyday life and technologies and also that mathematics is a living discipline that is still in development and whose development is in close interaction with that of science and technology. Another purpose of the course is that students (future teachers) experience what science is and how a scientist work. The course presents "flash-sciences" that can be covered within an hour and subjects that are treated during a whole week (3 hours of course and two hours of TA). Emphasis is put on mathematical modelling of real life problems, problem solving with a wide range of tools.

Several subjects are chosen so that to reveal the power of the mathematical method. Some mathematical sophistication allows to do far better than the ad hoc methods, for instance to build cryptographic methods that cannot be broken even after 25 years of hard effort. The role of the computer as a tool for the mathematician is also shown. Some characteristics of a scientist: he(she) asks questions. He has an open and critical mind. He(she) dares to say "I don't know." So during the course the students and the professors play the game of asking many questions, including many questions to which the professors do not know the answer.
Students must also make on project on an application of mathematics to technology or science (similar to a science fair project), write an essay on it and make an oral presentation. Examples of subjects treated during the course can be found on the website of the course:

www.dms.umontreal.ca/~rousseac/MAT2450.html

Here are some flash-sciences presented during the course:

- Antennas and radars are parabolic. Why?
- Optimize the number of antennas for cellular phones.
- Rollercoasters: From which height must we start in order to be able to make a complete loop?
- Vision of computers : be able to calculate the position of an object from his position on two pictures.
- Physics : unify the laws of reflection and refraction. The laws of nature obey to some optimization principles. Applications: optic fibers, short wavelengths.
- How the GPS works?
- How to localize the thunderstorms at Hydro-Québec?
- Some principles in cartography. How are drawn the marine maps

More elaborate subjects :

- Save and Boorw money
- Where we are in space : GPS, cartography, localization of thunderstorms, etc.
- How is music encoded on a CD : why 44100 numbers per second?
- Public key cryptography
- Error correcting codes
- Image compression : iterated fonction systems and fractals
- The JPEG format (.jpg)
- Robots
- Frises et mosaïques
- Gamma-knive radio-active surgery

(Several others chapters are planned. Time is missing!)
The projects of the students in winter 2003

- Rollercoasters
- How are curves slanted on a highway?
- The seasons : length of days, placeof surise and sunset,etc.
- Phyllotaxy (mathematical modeling of sunflower spirals)
- Fractals and the stock market
- Mathematical modelling of epidemics
- The calculation of astronomical distances, from the Greeks to now.
- The eclips
- The windshield factor
- The best skateboard track

- Pollution by electrical circuits
- DNA and knot theory

Some global messages coming out of the three sessions:

- The importance of having the students feel the “pulsation mathématique” (Nathalie please translate);
- The importance of putting young students in contact with the notion of proof;
- The importance of developing intuition;
- The limits of intuition and the need to also develop rigor;
- The need to be exposed to mathematics as an experimental discipline;
- The need to be exposed to the way a scientist works;
- The need to be exposed to the fact that mathematics is a living discipline inside science and technology.

Some directions of actions:

- Make sure that these messages be more widely spread by all means possible: change attitudes;
- One way is by preservice teacher education;
- Other ways are through repositories of good material and activities;
- One way is through inservice teacher education. We should then work with those who provide the inservice teacher education and try to build networks of collaboration and exchange of ideas.