Few pedagogical scenarios in Linear Algebra with Cabri and Maple.

By *Jacqueline Klasa-Bompoint.*

With the appearance of very rapidly improving technologies, since the 90's we have faced many reform movements introducing much more importance on the visualization of mathematical concepts together with more socialization (Collaborative learning). Just to name few reform groups in the USA: Harvard Group for Calculus and for Linear algebra: ATLAST organized by S. Leon after the ILAS symposium of 1992 and LACSG started with D. Lay in 1990 and then continued with D. Carlson (1993) and many others. However some researchers like J.P Dorier and A. Sierpinska were not optimist and declared "It is commonly claimed in the discussions about the teaching and learning of linear algebra, that linear algebra courses are badly designed and badly taught and that no matter how it is taught, linear algebra remains a cognitively and conceptually difficult subject". On the other hand, M. Artigue advocates strongly the use of CAS's but with a constant awareness that Mathematics learned in such an environment of software are changing. How do we really teach Linear algebra now? See the standard Anton's text book and then the much praised book "Linear Algebra and its applications" written in 1994 by D. Lay. How hard is it really now to teach and to learn this topic? We shall repeat like J. Hillel, A. Sierpinska and T. Dreyfus that the teaching of Linear Algebra offers to students many cognitive problems related to three thinking modes intertwined: geometric, computational (with matrices) and algebraic (Symbolic). We could follow the APOS theory of E. Dubinsky and see that it will be necessary for the teacher to proceed to a genetic decomposition of every mathematical concept of Linear Algebra before being able to conceive a pedagogic scenario that will have to bring students from the "action" to the more elaborated state of "process" and then luckily make them reach the most abstract levels of "objects" and even higher structured "schemes". While devising my classes and computer-labs to my students in Linear Algebra, I was inspired by all good ideas presented by the mentioned authors and many others as: G. Bagni, J.L. Dorier and Fischbein, D. Gentner, G. Harel, J. Hillel, J.G. Molina Zavaleta. I am a mathematician who teaches in a CEGEP, which is a special college of Qubec's province in Canada. Pedagogical scenarios based on Cabri and Maple will be presented in this study for some few stumbling blocks in the learning of Linear Algebra:

linear transformations, eigenvectors and eigenvalues, quadratic forms and conics with changes of bases, finally singular values. When immersed in this software environment, I restrict all the demonstrations to R^2 and R^3. Can visualization and manipulation improve and facilitate the learning of Linear algebra? As I am biased, of course I will say yes; really we would need a strong evaluation and analysis of this teaching procedure to be able to give answers. As Ed. Dubinsky would say "This situation provides us with the opportunity to build a synthesis between the abstract and concrete. The interplay between concrete phenomena and abstract thinking." I will add also, that students working in teams around computers (or even graphic calculators) only coached by the teacher at times, become experts in the discipline they experiment with. About the roles of the CAS Maple and the geometrical software, we will agree with the Cabrilog slogan "Cabri makes tough maths concepts easier to learn thanks to its kinaesthetic learning approach!" while Maple acts like a good big brother, doing all the boring calculations for the students and also producing instructive animations, unfortunately mostly programmed by the teacher.