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Section:

18. Teaching and Popularization of Mathematics

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Drawing instruments: the theory of a practice from history to didactics

Didactics of mathematics as a scientific discipline is fairly young compared to other sciences, yet deeply rooted in the perennial effort of mathematicians to advance human understanding of mathematics and to transmit mathematics knowledge to future generations. In recent years several efforts have been done at the international level (detailed references will be given in the paper) to clarify the objects, the aims, the research questions, the methodologies, the results and the criteria to evaluate the results of research in didactics of mathematics. It has become clear that analytical tools are needed from different disciplines (such as epistemology, history, psychology) to obtain results that can increase the knowledge of the teaching and learning processes in the classroom, produce effective innovation in schools or understand why some designed innovation does not work, and, at a larger level, influence the development of school systems. Anyway, the starting point of every discussion is the nature of mathematics knowledge. One of the distinctive features of mathematics is theoretical organisation. Unfortunately the production and even the understanding of mathematical proofs is supposed to be very difficult for the students all over the world. As a matter of fact, in some countries proofs are being eliminated from mathematics curriculum. This is the scenery where a collective project has been initiated some years ago by a group of Italian researchers. The project highlights the permanent value of proof in mathematics and mathematics education and aims to design, implement and analyse effective teaching experiments, that can introduce students into the theoretical dimension of mathematical culture. Experiments in different fields have been carried on at very different school levels, from primary school to university. In my lecture I shall focus on some experiments that concern activity with linkages and other drawing instruments at secondary and university levels. The main thesis of my lecture is the following: By exploring, with suitable tasks and under the teacher's guidance, linkages and other drawing instruments, secondary and university students can 1) be enriched with a well-balanced image of mathematics, where theoretical aspects and applications are strictly intertwined, yet not confused; 2) be involved in the generation of 'new' (for the learners) pieces of mathematical knowledge by taking active part in the production of statements and the construction of proofs in a reference theory, living an experience similar to the one of professional mathematicians; 3) be acquainted with a set of exploring strategies and representative tools that nurture the creative process of statement production and proof construction and are transferable to other sets of problems. This thesis will be defended by referring to research studies already published or in progress. Linkages and other drawing instruments belong to the historical phenomenology of geometry. A part of the lecture will be devoted to a sketchy reconstruction of this history from the time of Euclid to the present studies about algebraic and differential geometry of linkages and applications to robotics. Two red threads go through the whole history and concern the organisation in theories of individual linkages on the one side and of individual curves (later algebraic curves) on the other side. Linkages and other drawing instruments have a twofold nature: they are material objects that can be used for practical purposes and they are abstract objects that belong to a mathematical theory. Their material feature makes them good candidate for popularization of mathematics, by means of concrete or virtual copies. Yet the mathematical theory is hidden and not easy to be communicated. This shifts the problem to a correct didactical use of drawing instruments as far as the theoretical dimension of mathematics is concerned. In other words, it is necessary to pay attention to the choice of suitable tasks and to the teacher's role in structuring classroom activity. In this very part of the study, the function of analytical tools from epistemology of mathematics and psychology of mathematics education appears to be relevant.