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### 3. IS THERE A CRISIS IN THE TEACHING OF GEOMETRY?

During the second half of this century geometry seems to have progressively lost its former central position in mathematics teaching in most countries. The decrease has been both qualitative and quantitative. Symptoms of this decrease may be found for instance in recent national and international surveys on the mathematical knowledge of students. Often geometry is totally ignored or only a very few items concerned with geometry are included. In the latter case questions tend to be confined to some elementary “facts” about simple figures and their properties, and performance is reported to be relatively poor.

What are the main causes of this situation?

- From about 1960 to 1980 a general time pressure on traditional topics has occurred, due to the introduction of new topics in mathematics curricula (e.g. probability, statistics, computer science, discrete mathematics). At the same time the number of school hours devoted to mathematics has gone down. The “modern mathematics movement” has contributed — at least indirectly — to the decline of the role of euclidean geometry, favouring other aspects of mathematics and other points of view for its teaching (e.g. set theory, logic, abstract structures). The decline has involved in particular the role of visual aspects of geometry, both three-dimensional and two-dimensional, and all those parts which did not fit into a theory of linear spaces as, for instance, the study of conic sections and of other noteworthy curves.
- In more recent years there has been a shift back towards more traditional contents in mathematics, with a specific emphasis on problem posing and problem solving activities. However, attempts to restore classical euclidean geometry — which earlier in many parts of the world was the main subject in school geometry — have so far not been very successful. The point is that in traditional courses on euclidean geometry the material is usually presented to students as a ready-made end product of mathematical activity. Hence, in this form, it does not fit well into curricula where pupils are expected to take an active part in the development of their mathematical knowledge.
- In most countries the percentage of young people attending secondary school has increased very rapidly during the last decades. Thus the traditional way of teaching abstract geometry to a selected minority has become both more difficult and more inappropriate for the expectations of the majority of students of the new generations. At the same time, the

need for more teachers has caused, on average, a decline in their university preparation, especially with respect to the more demanding parts of mathematics, in particular geometry. Since younger teachers have learned mathematics under curricula that neglected geometry, they lack a good background in this field, which in turn fosters in them the tendency to neglect the teaching of geometry to their pupils.

The situation is even more dramatic in those countries which lack a prior tradition in schooling. In some cases geometry is completely absent from their mathematics curricula.

- The gap between the conception of geometry as a research area and as a subject to be taught in schools seems to be increasing; but so far no consensus has been found on how to bridge this gap, nor even whether it could (or should) be bridged through an introduction of more advanced topics in school curricula at lower grades.

#### 4. GEOMETRY AS REFLECTED IN EDUCATION

In former sections, we have considered geometry mainly as a mathematical theory and have analyzed some aspects of its *teaching*. Since *learning* is unquestionably the other essential pole of any educational project, it is now appropriate to pay due attention to the main variables which may affect a coherent teaching/learning process. Consequently, several different aspects or “dimensions” (considered in their broadest meaning) must be taken into account:

- *The social dimension*, with two poles:
  - The cultural pole, i.e. the construction of a common background (knowledge and language) for all the people sharing a common civilization;
  - The educational pole, i.e. the development of criteria, internal to each individual, for self consistency and responsibility.
- *The cognitive dimension*, i.e. the process which, starting from reality, leads gradually to a refined perception of space.
- *The epistemological dimension*, i.e. the ability to exploit the interplay between reality and theory through modelling (make previsions, evaluate their effects, reconsider choices). Thereby axiomatization enables one to get free from reality; this in turn may be seen as a side-step which allows further conceptualization.