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COMMISSION INTERNATIONALE DE L'ENSEIGNEMENT MATHÉMATIQUE

(THE INTERNATIONAL COMMISSION ON MATHEMATICAL INSTRUCTION)

PERSPECTIVES ON THE TEACHING OF GEOMETRY FOR THE 21st CENTURY

DISCUSSION DOCUMENT FOR AN ICMI STUDY

1. WHY A STUDY ON GEOMETRY?

Geometry, considered as a tool for understanding, describing and interacting with the space in which we live, is perhaps the most intuitive, concrete and reality-linked part of mathematics. On the other hand geometry, as a discipline, rests on an extensive formalization process, which has been carried out for over 2000 years at increasing levels of rigour, abstraction and generality.

In recent years, research in geometry has been greatly stimulated by new ideas both from inside mathematics and from other disciplines, including computer science. At present, the enormous possibilities of computer graphics influence many aspects of our lives; in order to use these possibilities, a suitable visual education is needed.

Among mathematicians ands mathematics educators there is a widespread agreement that, due to the manifold aspects of geometry, the teaching of geometry should start at an early age, and continue in appropriate forms throughout the whole mathematics curriculum. However, as soon as one tries to enter into details, opinions diverge on how to accomplish the task. There have been in the past (and there persist even now) strong disagreements about the aims, contents and methods for the teaching of geometry at various levels, from primary school to university.

Perhaps one of the main reasons for this situation is that geometry has so many aspects, and as a consequence there has not yet been found — and perhaps there does not exist at all — a simple, clean, linear "hierarchical" path from the first beginnings to the more advanced achievements of geometry. Unlike what happens in arithmetic and algebra, even basic concepts in geometry, such as the notions of angle and distance, have to be reconsidered at different stages from different viewpoints.

Another problematic point concerns the role of proofs in geometry: relations between intuition, inductive and deductive proofs, age of students at which proofs can be introduced, and different levels of rigour and abstraction.

Thus the teaching of geometry is not at all an easy task. But instead of trying to face and overcome the obstacles arising in the teaching of geometry, actual school-practice in many countries has simply bypassed these obstacles, cutting out the more demanding parts, often without any replacement. For instance, three-dimensional geometry has almost disappeared or has been confined to a marginal role in the curricula in most countries.

Starting from this analysis, and specifically considering the gap between the increasing importance of geometry for its own sake, as well as in research and in society, and the decline of its role in school curricula, ICMI feels that there is an urgent need for an international study, whose main aims are:

— To discuss the goals of the teaching of geometry at different school levels and according to different cultural traditions and environments.

— To identify important challenges and emerging trends for the future and to analyze their potential didactical impact.

— To exploit and implement new teaching methods.

2. Aspects of geometry

The outstanding historical importance of geometry in the past, in particular as a prototype of an axiomatic theory, is so universally acknowledged that it deserves no further comment. Moreover, in the last century and specifically during the last decades, as Jean Dieudonné asserted at ICME 4 (Berkeley, 1980), Geometry "bursting out of its traditional narrow confines [...] has revealed its hidden powers and its extraordinary versatility and adaptability, thus becoming one of the most universal and useful tools in all parts of mathematics" (J. Dieudonné: The Universal Domination of Geometry, ZDM 13 (1), p. 5-7 (1981)).