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3.3. The treatment of particular areas

The peripherals used (screen, printer, plotter, ...) determine different ways of using informatics. The adaptation to mathematics poses some general problems, like that of the handling of symbolic writing which is not linear, despite the apparent linear sequence of characters in a normal text. For example, consider the various methods employed to reduce to a linear form mathematical statements often best presented in the form of a tree.

We now consider methods of employing the computer to meet needs to be found in various areas of mathematics which are taught at the levels of education under consideration.

In all of these branches one will note the central rôle of visualisation, of experimentation, of simulation, and of the way in which the computer fosters the generation and refining of conjectures.

First, however, we pose a general question. A certain number of fundamental concepts are used in the teaching of mathematics, often in an implicit manner, for example, intuitive logic, the concepts of a variable, of a function, ... Can informatics help us bring precision to, and increase our understanding of, such concepts?

Statistics and probability; data processing. The computer permits the processing of data on a truly grand scale. Problems of sorting data into classes are no longer relevant. Again, simulation is a tool which can hold a place in probability similar to that of plotting figures in geometry. Thus it is possible, thanks to pseudo-random techniques for selection, to provide "reality" for all types of conceivable situations—betting, decision making, testing ...

Geometry. The production of graphical images (e.g. perspective views of objects in space, orbits) and the concept of computer-aided design (graphics software) are extremely helpful for the development and fostering of intuitions. They make it possible to explore geometric objects and figures and provide access to new figures. What changes does plotting by means of a computer introduce with respect to geometry founded on the use of ruler and compass?

Linear algebra. The algorithmic approach furnishes tools for mathematical demonstrations (e.g. pivotal condensation) and leads us to approach in a different manner the study of such questions as inversion, the solution of systems of equations, and the decomposition of matrices. Moreover, visualisation can give support to intuition, e.g. for the study of eigenvalues and of diagonalisation. Do not such techniques as the simplex method merit a place in our teaching?

Analysis. As a result of the effects of symbolical systems, exercises on differentiation, searching for primitive integrals and finding finite Taylor series, are destined to decrease in importance. On the other hand, the graphical representation of functions and finding approximate solutions of numerical or functional equations will become worthy of additional consideration. Experimentation can provide opportunities for the discovery and formulation of qualitative properties before they are formally proved, for example, for the solution of differential equations. Approximation brings with it problems of convergence, beginning with sequences and series. Moreover, the qualitative aspect of the concept of convergence, the numerical study, leads naturally to the quantitative aspect, speed of convergence. Finally, discretisation provides a further field for experimentation, e.g. for functional equations.

Numbers, numerical analysis. The numbers of a machine are very different from those of a mathematician. This leads one to explore the differences and, *en passant*, to consider the principles of numerical symbolism. In another connection, should we be taking the use of parallel processors for research in numerical analysis into account at the teaching level?

Sets, combinatorics, logic. The methods of working now force one to give operative definitions (the enumeration of surjections $S(n, p)$ is a simple example of recursivity, which also allows one to give a working meaning to a surjection). In this area, too, the rapid production of numerical results permits easy exploration and the devising of conjectures. Does the learning of formulae by experience constitute a particular current interest in this field?

In traditional fields of study there are subjects which demand new and special attention because of the particular characteristics of working on a machine: that it uses discrete methods. It is important, therefore, to pay attention to theoretical approaches to discrete topics (e.g. difference equations); at this time, complete courses of discrete mathematics are being proposed for students. Is it really true that this provides us with a new theme for teaching?