# SUMMARY

This thesis deals with a teaching experiment on the teaching of mathematics with the help of the programming language, Logo, in forms 5 and 6 (age groups 11 - 12) in the Swedish primary school.

The thesis starts with a constructivistic theory of learning, especially applied to mathematics, as it has, above all, been rendered by Richard Skemp. After that, some theories and research results on pupils' comprehension of numbers and of geometric concepts are discussed.

A rather exhaustive part of the thesis deals with the programming language Logo. The construction of the language and its potential advantages for pupils' learning of Logo. The construction of the language and its potential advantages for pupils' learning of mathematics are discussed, as are the thoughts and intentions of Seymour Papert, the originator of the language, when introducing this language as an aid to children's thinking. The results that have been achieved when using Logo in various ways in research projects in , above all, the U S A and the United Kingdom are discussed. The language and its use in school instruction have been criticized by various authors, and this criticism is also considered.

The aim of the project has been to investigate - with the theory accounted for as a background -whether pupils in the Swedish primary school may profit from programming in Logo during one period per week, especially whether this occupation may affect their knowledge of arithmetic and geometry and their problem solving ability. The aim has been summarized in the following problem specification:

How are pupils in forms 5 and 6 of the Swedish primary school affected when given the opportunity to program in Logo during one period per week in accordance with a work plan, in which there are great possibilities for the pupils to investigate and to experiment on their own:

1. Is there a change in the pupils' knowledge of geometry and arithmetic?
   Is there a change in the pupils' conception of number?
   Is there a change in the pupils' ability to solve problems?

2. How much do the pupils grasp of the ideas behind Logo programming?

3. Is the pupils' attitude to computers and the information society affected, if they are given the opportunity to program computers at junior school?

4. Is the pupils' attitude to mathematics as a subject affected?
   Is there any difference here between boys and girls?
   In that case can this difference affect the development of knowledge in mathematics of boys and in girls in different ways?

The experiment was carried out in two classes that were followed through forms 5 and 6 during the school years 1986/87 and 1987/88. Two comparison classes from the same school management area and with as equal prerequisites as the experimental classes as possible were also part of the project. Work sheets, which had been written by the author, with about ten sections per school year were used. In each such section a new programming technique or in some cases a new mathematical idea was presented to the pupils. Every section was built up in the following way:

The pupils got a new instrument to work with. Typical examples were given. The pupils worked on their own with given figures and similar exercises. The pupils invented their own figures and other exercises.

Tests in mathematics and programming, clinical interviews on mathematics and programming, questionnaires, interviews with pupils and with teachers, and observations were used as methods of evaluation. The results of this evaluation are exhaustively accounted for in the thesis. In addition there are case studies from pupils with different pre-knowledge in mathematics.

In the thesis there are numerous examples of how the pupils of the experimental classes were able to take advantage of the way they worked with discovery and investigation in Logo. It can also be seen how an erroneous step - seen from the point of view of an intended result - could still lead to an interesting and very often amusing figure. In that way the pupils got an attitude to mathematics that differed from that usual in traditional mathematics instruction; they discovered that a problem might be solved in different ways, that you can examine different ways to tackle a problem in a creative way, and that there is not necessarily one correct and one false answer to every question in mathematics.

'Me teacher's role was also different in Logo instruction compared to traditional instruction. Her/his task was more to organize the work of the class, to encourage the pupils to reflect on what they are doing, and to give them work tools, ideas, and suggestions, when they feel a real need for them. 'Me pupils also had the opportunity of working together and in that way to compare and discuss each other's trains of thought.

In the way mentioned above the pupils had numerous opportunities to learn and to work with concepts and concept structures. In the thesis there are many examples of how the pupils assimilated

their experiences at the computer in their ready-made schemas, and of how their schemas were differentiated, expanded, and also reconstructed. The pupils' motivation for computer work was strong, even if some pupils got less enthusiastic towards the end of the project time.

The drawbacks that instruction with Logo might give rise to are also discussed in the thesis. It sometimes happened that the system and the application programs caused trouble, and that the teacher had difficulties in finding the error. Above all the technical details, which you always need to know to be able to use a programming language, might cause the pupils unnecessary trouble. The formal side of Logo might hide the mathematical content that the instruction with Logo was intended to make clear to the pupils. Moreover the Logo environment tended to be a special subjective domain of experience to the pupils, which had very little in common with school mathematics or with the informal mathematics that they used outside school.

The teacher in one of the experimental classes, f 1, used Logo more freely and openly than the other experimental teacher, i. e. he let his pupils work more on their **own and restricted** his own teaching to a very minimum. This fact has been supported partly by interviews with the teachers and partly by tape recordings from Logo periods, one from each class. The difference in teaching style was mirrored in the test results.

The quantitative evaluation showed that the result development was better in the experimental than in the comparison classes in arithmetic, in geometry, and in problem solving. However, the latter result was not significant, and is thus uncertain. The results in arithmetic and geometry were wholly due to the development in class f 1. The motivation for mathematics also developed more positively in the experimental than in the comparison classes and again this was above all the fact in class f 1. The central results are summarized in figure 1.

On the **upper** line the branches of mathematics where the comparison classes showed better results have been reported to the left and those where the experimental classes had better results to the right. On the next line the results from the two experimental classes are compared in the same way, and on the third line the results from girls and boys respectively in the experimental classes are seen.

The benefits of Logo were, thus, that it gave the pupils the possibility, even forced the pupils, to employ an active, exploring, and discovering style of learning. The pupils' own ideas and suggestions were carried out, and the computer gave an immediate and automatic feedback. But at the same time one or more erroneous commands would still lead to an interesting and often amusing result.