CHAPTER 4: MATHEMATICAL KNOWLEDGE AND PROGRESS IN THE MATHEMATICAL LEARNING OF CHILDREN WITH SPECIAL NEEDS IN THEIR FIRST YEAR OF SCHOOL

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The paper is a summary of an empirical study which showed that the "mathe 2000" approach is feasible also for children with special needs.

A research project conducted by the Institute for Special Education at the University of Freiburg, Switzerland, has evaluated the mathematical knowledge of children with special needs at the start of their school education. One definition of "special needs" is children with learning disabilities. In Switzerland, these children are assigned to special classes where, as a criterion, an intelligence quotient between 75 and 90 is employed. Alternatively, so-called "introductory classes" are common in Switzerland. This kind of class is meant for children with partial delay in their development and, in some cases, when the maturity level required for entering the first class is questionable. Here, the subject matter of the first class is extended over two years. The children then enter either the second year of the mainstream class, or a special class for children with learning disabilities.

Current approaches to initial mathematical teaching are strongly marked by an understanding of the concept of numbers developed by Piaget. It recommends introducing numbers step-by-step after a lengthy pre-numerical practice (several months, up to one year). Classification, seriation and number-conservation are considered as prerequisites for understanding numbers. However, the "mathe 2000" approach (Wittmann; Müller, 2000) offers the sphere of numbers between one and twenty simultaneously. Exercises, which precede concrete calculation, are completely lacking. In addition, the emphasis lies on working with images of quantities with a given structure. The reasons for this are as follows:

There are many studies showing that the numerical knowledge of first-grade children in mainstream classes is much higher than traditional schoolbooks assume. Lengthy pre-numerical practice, based on the concept of number by Piaget, is ignored because such an approach to mathematical learning is under question. For example, many studies show that number-conservation is not a prerequisite for the development of mathematical abilities (Wember, 1989; 1998; Moser Opitz, 2001, p. 48f). Nowadays, it is known that children acquire mathematical knowledge by solving meaningful mathematical problems and not by solving tasks like conservation and class-inclusion. Furthermore, it is important to present the sphere of numbers from 1-10 or 1-20 immediately. A separate number can only be understood as a part of a whole, in the context of a larger area of numbers. A step-by-step introduction of numbers hinders such an overview and, consequently, understanding. To help children to represent numerical quantities, it is important to use sets with a given structure of five

or ten. This structure should help them to internalise the concept of numerical quantities.

In the practice of special education, some critical questions about this new approach have arisen. It is doubtful if children in special classes have the prerequisites necessary to work in the sphere of numbers from one to ten or one to twenty immediately. In addition, it is difficult for teachers to accept that pre-numerical practice, which used to and still does characterise the teaching of mathematics in special education, is questionable. Furthermore, there are doubts over whether children in special classes are actually able to acquire the concept of numerical quantities from one to twenty. This situation has led to the questions the intended research project seeks to address:

- What kind of numerical knowledge do children in special classes bring into school?
- Do children in the first year of a special class, who are taught according to the ”mathe 2000” approach, make more, less or similar progress in mathematical knowledge than children taught according to current (special education) methods?
- What conclusions can be drawn from this information for initial mathematics teaching?

Method

The subjects of the study were 162 children (59 female, 103 male), schooled in special classes at the start of their school education. The average age was 6 years 9 months. The test comprised two parts, ”prerequisites” (pre-numerical practice; comprehension of quantities; grasp of numerical quantities; counting; number words and writing of numbers) and ”calculation” (addition and subtraction from 1-20 with and without counting aid). The test was given in the form of a gold coin game and the children were tested individually (cf. Moser Opitz, 2001, 126f).

Results

The results are given as percentages. Where a percentage range is given, different scores were given for different tasks.

The results show that the children's numerical knowledge at the start of their school education is higher than current approaches to special education presuppose (table 1). Most of children managed the pre-numerical tasks and had a comprehension of quantities from 1 to 6. More than half of them knew the number words from 1 to 10 and a similar number were able to write numbers from 1 to 5 (cf. Moser Opitz, 2001; 1999a; 1999b). The addition tasks, with the possibility of counting within the first ten, were completed by 43-66% of the children, the subtraction tasks by 32-40%. It shows that the ability of children with learning disabilities is lower than in mainstream classes, where the score for the addition is 80% and for the subtraction 40%. Only a few children were able to solve addition and subtraction without counting aids.

Task	% (N = 162)
Prerequisites	
Pre-numerical Practice	
Classification (multiple)	66.7
Seriation	72.0
One-to-one-correspondence	89.5
Comprehension of quantities	
Take n objects	88.3-98.8
Number words from 1-10	69.8-92.6
Writing of numbers	
Numbers from 1-5	46.3
Numbers from 1-10	29.6
Counting	
Counting forward to 20 (and further)	55.6
Counting backwards from 6	49.4
Calculation	
Addition with counting aid from 1-10	43.2-66
Subtraction with counting aid from 1-10	32.1-40.8
Addition without counting aid from 1-10	20.3-27.1
Subtraction without counting aid from 1-10	5.5-6.2

Table 1: Numerical knowledge of children with special needs at the start of their school education

The second part of the research project examined the improvement in mathematical knowledge in the first year of school. Based on written reports by the teachers, three different groups were matched. One group was taught according to the current approaches to mathematical teaching with lengthy pre-numerical practice, the second group by the ”mathe 2000” approach (including working in the sphere of numbers from 1-20 and laying emphasis on the recognition of sets with a given structure) from the beginning of their school education and the third group started working with the ”mathe 2000” approach during the first year of school. Eight months after the start of their school education, the children were tested again.

The scores of the second and third group were, in some areas (number words, writing of numbers, recognising sets with a given structure) but not overall, significantly better than those of the first group. Interestingly, the group which has worked with images of quantities with a given structure from the beginning of their school education used (finger) counting strategies significantly less in addition and subtraction than the other groups. This is an important finding because it is known that one symptom of children with learning disabilities in mathematics is the frequent use of finger counting strategies (Geary; Brown; Samaramayake, 1991).

The results of the study presented here show that the numerical knowledge of children with special needs at the beginning of their school education is much higher than current approaches in special education presuppose. These common teaching materials, which prescribe pre-numerical practice during several months or a whole year without using numbers, can be considered questionable. Moreover there are good reasons to conclude that working with the ”mathe 2000” approach helps children to develop their concept of number. Particularly, working with sets with a given structure seems to supply number representation and the practice of addition and subtraction. Early mathematical teaching for children with special needs should take these results into account and adapt its methods.

In addition, interviews carried out with special education teachers (Moser Opitz, 1999c, 172) show that they lack knowledge as to how to adapt the ”mathe 2000” approach to children with special needs (e.g. with regard to perception, spatial organisation, memory problems). This should be taken into consideration. More guidance to special education teachers for teaching the ”mathe 2000” approach is necessary.

References

Geary D.C.; Brown, S.C.; Samaranayake, V.A. (1991): Cognitive addition: A short longitudinal study of strategy choice and speed-of-processing differencies in normal and mathematically disabled children. In: *Developmental Psychology*, 787-797.

Moser Opitz, E. (1999a): Mathematischer Erstunterricht im heilpädagogischen Bereich: Anfragen und Überlegungen. In: *Vierteljahresschrift für Heilpädagogik und ihre Nachbargebiete* 3, 293-307.

Moser Opitz E. (1999b): Lernbehinderte Kinder nicht unterfordern. Zur Situation des heilpädagogischen Mathematikunterrichts in der Schweiz. In: Neubrand, M. (Hrsg.): *Beiträge zum Mathematikunterricht*. Vorträge auf der 33. Tagung für Didaktik der Mathematik vom 1.-5. März 1999 in Bern. Hildesheim/Berlin 381-384.

Moser Opitz, E. (1999c): Zahlbegriffserwerb und Mathematik-Erstunterricht. Eine empirische Untersuchung zu Rechenfähigkeiten von Erstklässlern in Kleinklassen und zu mathematischen Unterrichtskonzeptionen. Unveröffentlichter Teil aus der Dissertation zur Erlangung der Doktorwürde an der Philosophischen Fakultät der Universität Freiburg/ CH.

Moser Opitz, E. (2001): Zählen – Zahlbegriff – Rechnen. Theoretische Grundlagen und eine empirische Untersuchung zum mathematischen Erstunterricht in Sonderklassen. Bern/Stuttgart/ Wien (Haupt).

Wember, F.B. (1989): Die sonderpädagogische Förderung elementarer mathematischer Einsichten auf entwicklungspsychologischer Grundlage. Das Beispiel des Zahlbegriffs. In: *Zeitschrift für Heilpädagogik* 7, 433–443.

Wember, F.B. (1998): Zahlbegriff und elementares Rechnen. Vorschläge zur Diagnose und Intervention bei Kindern mit Lernstörungen. FernUniversität –Gesamthochschule Hagen.

Wittmann, E.Ch; Müller, G. (2000): Das Zahlenbuch. Mathematik im 1. Schuljahr. Leipzig/ Stuttgart/Düsseldorf.