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MATHEMATICS IN THE STREETS AND IN SCHOOLS**

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Abstract. An analysis of everyday use of mathematics by working youngsters in commercial transactions in Recife, Brazil, revealed computational strategies different from those taught in schools. Performance on mathematical problems embedded in real-life contexts was superior to that on school-type word problems and context-free computational problems involving the same numbers and operations. Implications for education are examined.

1. Introduction

There are reasons for thinking that there may be a difference between solving mathematical problems using algorithms learned in school and solving them in familiar contexts out of school. Reed & Lave (1981) have shown that people who have not been to school often solve such problems in different ways from people who have. This certainly suggests that there are informal ways of doing mathematical calculations which have little to do with the procedures taught in school. Reed & Lave's study with Liberian adults showed differences between people who had and who had not been to school. However, it is quite possible that the same differences between informal and school-based routines could exist

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within people. In other words, it might be the case that the same person could solve problems sometimes in formal and at other times in informal ways. This seems particularly likely with children who often have to do mathematical calculations in informal circumstances outside school at the same time as their knowledge of the algorithms which they have to learn at school is imperfect and their use of them ineffective. We already know that children often obtain absurd results such as finding a remainder which is larger than the minuend when they try to apply routines for computations which they learn at school [4]. There is also some evidence that informal procedures learned outside school are often extremely effective. Gay & Cole (1976) [9] for example showed that unschooled Kpelle traders estimated quantities of rice far better than educated Americans managed to. So it seems quite possible that children might have difficulty with routines learned at school and yet at the same time be able to solve the mathematical problems for which these routines were devised in other more effective ways. One way to test this idea is to look at children who have to make frequent and quite complex calculations outside school. The children who sell things in street markets in Brazil form one such group [14]

2. **Main Results**

The children were found by the interviewers on street corners or at markets where they worked alone or with their families. Interviewers chose subjects who seemed to be in the desired age range-school children or young adolescents-obtaining information about their age and level of schooling along with information on the prices of their merchandise. Test items in this situation were presented in the course of a normal sales transaction in which the researcher posed as a customer. Purchases were sometimes carried out. In other cases, the 'customer' asked the vendor to perform calculations on possible purchases. At the end of the informal test, the children were asked to take part in a formal test which was given on a separate occasion, no more than a week later, by the same interviewer. Subjects answered a total of 99 questions on the formal test and 63 questions on the informal test. Since the items of the formal test were based upon questions of the informal test, order of testing was fixed for all subjects. The analysis of the results from the informal test required an initial definition of what would be considered a test item in that situation. While, in the formal test, items were defined prior to testing, in the informal test problems were generated in the natural setting and items were identified posteriori. In order to avoid a biased increase in the number of items solved in the informal test, the definition of an item was based upon questions posed by the customer/tester. This probably constitutes a conservative estimate of the number of problems solved, since subjects often solved a number of intermediary steps in the course of searching for the solution to the question they had been asked. Thus the same defining criterion was applied in both testing situations in the identification of items even though items were defined prior to testing in one case and after testing in the other. In both

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testing situations, the subject's oral response was the one taken into account even though in the formal test written responses were also available. Context-embedded problems were much more easily solved than ones without a context. This research showed that 98.2 percent of the 63 problems presented in the informal test were correctly solved. In the formal test word problems (which provide some descriptive context for the subject), the rate of correct responses was 73.7 percent, which should be contrasted with a 36.8 percent rate of correct responses for mathematical operations with no context. The results seem to be in conflict with the implicit pedagogical assumption of mathematical educators according to which children ought first to learn mathematical operations and only later to apply them to verbal and real-life problems. Real-life and word problems may provide the 'daily human sense' (Donaldson, 1978) [8] which will guide children find a correct solution intuitively without requiring an extra step-namely, the translation of word problems into algebraic expressions. This interpretation is consistent with data obtained by others in the area of logic, such as Wason & Shapiro (1971) Johnson-Laird et al. (1972) and Lunzer et al. (1972) [16] [10] [12].

3. Conclusions

In the informal test, children rely upon mental calculations which are closely linked to the quantities that are being dealt with. The preferred strategy for multiplication problems seems to consist in chaining successive additions. In the formal test, where paper and pencil were used in all the above examples, the children try to follow, without success, school-prescribed routines. Mistakes often occur as a result of confusing addition routines with multiplication routines. Summarizing briefly, the combination of the clinical method of questioning with participant observation used in this project seemed particularly helpful when exploring mathematical thinking and thinking in daily life. The results support the thesis proposed by Luria (1976) [13] and by Donaldson (1978) [8] that thinking sustained by daily human sense can be-in the same subject-at a higher level than thinking out of context. They also raise doubts about the pedagogical practice of teaching mathematical operations in a disembedded form before applying them to word problems. Our results are also in agreement with data reported by Lave et al. (1984), who showed that problem solving in the supermarket was significantly superior to problem solving with paper and pencil. It appears that daily problem solving may be accomplished by routines different from those taught in schools. In the present study, daily problem solving tended to be accomplished by strategies involving the mental manipulation of quantities while in the school-type situation the manipulation of symbols carried the burden of computation, thereby making the operations 'in a very real sense divorced from reality' (see Reed & Lave, 1981, p. 442) [15]. The sort of mathematics taught in schools has the potential to serve as an 'amplifier of thought processes', in the sense in which Bruner (1972) [2] has referred to both mathematics and logic. As such, we do not dispute whether 'school math's' routines can offer richer

and more powerful alternatives to math's routines which emerge in non-school settings. The major question appears to center on the proper pedagogical point of departure, i.e. where to start. We suggest that educators should question the practice of treating mathematical systems as formal subjects from the outset and should instead seek ways of introducing these systems in contexts which allow them to be sustained by human daily sense.

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