

260 Lincoln Avenue
Amherst, Ma, 01002
November 7, 1972

Dear Mrs. Rasmussen:

I like your paper for Bahia Blanca, as I already told you on the phone. Indeed, I like it very much.

My only comments are general ones, directed toward some general principles in education and the teaching of mathematics.

First of all, my own theory is that mathematical thinking rests on a relatively small number of mental processes that children begin to execute in an un verbalized but compulsive way long before schooling begins. As they mature they become aware of these processes, they coordinate them progressively and they become skillful in handling them in a more and more integrated fashion, both verbally and operationally. The coordination and integration result at first from interaction with the external world but are gradually internalized as the child learns to use mental images, words, and other symbols. His perception of mathematics passes from a concretely oriented one to an increasingly internal, abstract one.

From this theory, I draw certain conclusions. The individual child inevitably passes through recognizable and fairly sharply separated stages in this process of maturation, but at an individual pace not quite so rigidly conditioned biologically as Piaget would have it. (As the child teacher through experience, discovery, and exercise he needs to (and naturally will) pass from the concrete to the abstract. As verbalization and other forms of symbolization play an important part in this development, the child is helped by having abundant opportunities and challenges to discuss what to learn and discover. Eventually discussion leads to argumentation and even the discovery of logical principles, probably (at least in a rudimentary form) earlier than many people are willing to believe. Furthermore, at a much earlier age than is done in most cases, attention should be directed (always at the "concrete" level in the beginning) toward those mathematical experiences most closely tied to the basic mental processes mentioned above. What intrigues me most about Madame Papy's elementary mathematics program is her success in doing just this. The early acquaintance with relations and graphs is a striking example of this in her program.

I also draw the conclusion that what is done in the elementary school needs to be oriented towards an increasing degree of abstraction so that at the appropriate stage a shift over to the stage where the child has fairly well learned to internalize mathematics and begins to discover how his acceptance of mathematics as a mental abstraction needs to be turned outward to deal actively with concrete situations. I would not be sure that for most children this shift over takes place often rather rapidly, at around age 11-12. It does seem to be this a common experience of many people over many decades that, for various

reasons (of which the one under discussion here may be one) this age level does have psychological significance. A factor operative in this phenomenon could well be the "socialization" of the child as he adapts himself to the culture and the structure of the society in which he is reared. Certainly in high school young people move simultaneously toward abstraction and use. I believe the elementary school teacher needs to guide her children into experiences preparing them for this higher stage.

Secondly, I have some serious reservations about the extent to which interaction between school and community can be practical or effective. While I would agree that interaction is desirable and quite feasible under almost any circumstance, I would expect the circumstances to set limits to possible achievements. Some of the limits would arise out of costs (not just money costs, but costs in energy, time and so on), others out of the cultural limitations of the members of the community (education, motivation, subjection to the environment, for example). I think it would be profitable to discuss this question when we meet in Bahia Blanca, with particular reference to Latin America conditions but with a few glances at other areas. I think we would agree that what is done in any community must begin by adaptation to the local situation but must also win the consent of the community, perhaps very gradually, to substantial adaptation of the community to the larger community of which it is a part. In Latin America education must draw much closer to the way of life in small, relatively isolated communities but it must also prepare some of the young people for more active rôles in the larger community and in circumstances quite different from those under which they grew up.

Sincerely yours,

Marshall Stone