Children's mathematical power

Piagetian developmental psychology has been a significant and positive force in Canadian mathematics education. However, it has also had some negative impact. Too often, it has resulted in educators underestimating the mathematics that children can learn and do. It may be illuminating to relate this circumstance to teaching practice in many European and Asian elementary schools. The following is typical of the kind of practice that one can find there. It concerns some regular classes of grade 3 students in the former Soviet Union (cited in Kierans, 1992).

> Graduated water containers with water in them had water levels marked by elastic bands. The contents of two such containers were poured into an empty container. The resulting water level was marked with an elastic band. Children did not use numbers to represent the water levels. Rather, they used letters. They wrote number sentences such as 'k + r = b' that reflected the action in the activity. They also wrote all valid transformations of the number sentences, as for example, 'b – r = k'. These abilities indicate that the children understand part/whole distinctions and that they have a functional understanding of the inverse relationship between addition and subtraction.
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> They also transferred their understandings to different contexts. For example, they handled with little difficulty problems such as: "In the morning 'n' tractors worked on the land. In the course of the day some tractors joined them. Then there were 'b' of them working. How many had joined them?" For this problem, the children wrote the number sentence that reflected what was going on: 'n + ? = b" and also transformed it to a form more suitable for computational purposes, namely, '? = b – n'.

It is highly unlikely that you would find the type of activity described above in grade 3 classrooms in Canada. Piagetian psychology would say that children are not capable of it because they are not at the correct stage of development yet. However, there is good evidence to suggest that they are capable of it. Research has found that, as early as Kindergarten, children can solve a variety of basic word problems that involve one of the four arithmetic operations (Carpenter et al, 1993). These findings suggest that young children can solve a range of problems at a far younger age than has been conventionally thought. The secret seems to lie in how children are taught rather than what they are "naturally" capable of. In other words, the matter may have more to do with the quality of teaching rather than with some assumed lack of developmental readiness of young children.

By the time children come to school, as long as they are dealing with their immediate world, most can show skills at thinking to a degree which must command our respect (Donaldson, 1979). Their immediate world of experiences, ideas, and relationships makes sense to them and is the object of their thinking. However, children have only a limited awareness of the means that they use to make sense of their world, nor do they tend to reflect upon those means in the abstract.

Their skills are used to serve their immediate and compelling purposes (such as figuring out how to open the refrigerator so as to get at the yummy ice cream). Children normally do not notice how they use their skills. Therefore, they cannot easily call them into service to tackle problems that do not arise out of their comfortable and familiar immediate world.

Yet in schools, children are expected quite often to tackle problems and learn skills posed by adults where those problems and skills are presented in abrupt isolation from the world of children and where the purpose of those adult-imposed demands tends to be obscure. For children, those demands are unnatural. That realization has led some concerned educators to argue that outside demands of any kind should be minimal. Instead, children should be offered experiences from which to learn. They should be encouraged to ask their own questions and be helped to solve those that interest them. In all of that, they should be allowed to be spontaneous and unconstrained in their learning. Behind such visions, there lies a metaphor that goes something like this. The child is a developing flower that is at risk of being stunted in the darkness and the sterile soil of the traditional classroom, and that is at risk of being trained to assume some perverse and unnatural form by the too confining hands of a teacher or of a school system.

These risks are real enough, but children are not flowers that have only a single natural way of blooming. Children are alive with human potential and richly varied possibilities for realizing that potential. The key to realizing their cognitive potential lies in the empowerment of their minds through challenging experiences, but children cannot do it by themselves. Without help, it would be a long and slow journey, and too few children would make enough progress. If their minds are to be fully developed, children must be aware of, understand, and gain control of their own thinking. To accomplish this, they need to move beyond the boundary of their familiar world of concrete experiences into the unfamiliar world of the systematized knowledge of adults. Children cannot readily move in that direction alone as that movement is the product of a long history of human culture. Teachers and others will have to help.

Mathematics education reform offers a way to help, one that is based on an optimistic view of children's mathematical power. Teachers should use children's familiar experiences and ideas as the starting point of instruction and gradually develop learning goals that are necessary for the future well-being of children and society-at-large, where children see new learning as a problem-to-be-solved. Doing so is likely to activate and enhance children's mathematical power in substantial and rich ways.

References

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