

Papert, Seymour, *Mindstorms: Children, Computers and Powerful Ideas*. Toronto: Fitzhenry & Whiteside, 1980, VIII, 230 pp, \$9.50.

I imagine that even those of you who have not read Papert's popular book will have heard something about LOGO, Turtles, and how they can be used to help children learn Mathematics. For those who have not, briefly: LOGO is a computer language that children can learn easily, and by means of which they can control the activities of a robot "Turtle", making it draw any shapes and patterns they want. By exploring the possibilities of this "Turtle geometry" they can discover a large number of basic mathematical concepts without fear and in a way that is fun.

However, *Mindstorms* is not really about Mathematics, nor even about computers. It discusses issues that are considerably wider-reaching and that go to the very roots of how we educate children. In eight chapters plus an epilogue, ranging from a description of LOGO in action, to a new interpretation of Piagetian theory, to revolutionary suggestions about how education might be remade, to a discussion of Mathematics and Aesthetics based upon the writing of Poincaré, Papert challenges so many of the basic assumptions that educators make about what they do and how they should do it that the reader comes away stimulated to the point of exhaustion. There is a uneasiness in education at present, traceable, I believe, to a growing awareness of the fact that a lot of what goes on in classrooms is unexplainable in terms of what we have been taught to expect. Students don't behave as we think they will. Presenting knowledge as having a coherence defined by formal logic seems to hinder as often as it helps learning. Students have an unshakeable and, to us, unreasonable fear of certain subjects. In Papert's scheme phenomena like these are explained, and solutions offered to the problems they appear to create. Papert's approach may not be easy to accommodate. As he admits (p. 186), his philosophy tends towards the "revolutionary rather than the reformist". But it is in such a philosophy that the means may be found to restore education to the position it should occupy in our society.

Since the book contains so much that is thought-provoking, I will attempt to present just a sampling of what, for me, were indeed "powerful ideas". The first of these is the idea of the "object-to-think-with". The archetype is, obviously, the Turtle itself. Rather than learning geometry through theorems and formulae, the child learns by "teaching the Turtle a new word". Such a word might be "circle" or "square" which, in computer talk, names a user-defined procedure in the LOGO language. In teaching the Turtle "circle", the child has to discover a set of instructions that will make the Turtle draw one. This is done through a learning process that involves intuition, experimentation and "debugging". And if the child gets stuck, it is common to "play Turtle", which requires the child to walk through the movements that the Turtle must make. Thus fundamental mathematical concepts are directly relative to movements under the students' control, whether they are the Turtle's movements or their own. This makes it much easier for children to understand the basic ideas of Mathematics in terms of what they already know.

A second powerful idea is the notion of "microworlds". A microworld is an environment in which the child explores the relationships between events and phenomena. The Turtle provides a microworld for exploring geometry. Another microworld can be constructed in which objects obey the laws of Newtonian Physics. The Turtle in the Geometry microworld can be given instructions to move a certain distance in a certain direction. It has position and heading. To create a microworld for Newtonian Physics, two new creatures are introduced: the Dynaturtle and the Acceleration Turtle. The former responds to commands concerning direction and speed. It has heading and velocity. The latter responds to commands concerning direction and change of speed. It has heading and acceleration. Again, by intuition, experimentation and "playing Turtle", the child can come to know basic principles of how objects behave as they move, change direction, accelerate and decelerate according to the Newton's laws of Physics.

The point of using the Turtle and its cousins to let children explore what would otherwise be difficult ideas is that the Turtle gives children something real to which they can relate what they discover. This avoids what Papert calls "dissociated learning". Formulae and theorems are abstract and meaningless in terms of what the child can understand. This leads to another important idea, that of learning as "tinkering". Content that to educators might have all the appearance of being logically structured

often seems to learners to be chaotic and contradictory. The learning of algorithms for dealing with content is therefore meaningless until the child has had time to "play around" with the ideas, to stand them on their heads, to look at them forwards, backwards and sideways, until they make some sort of personal sense. As an object-to-think-with, the Turtle is therefore also an object to tinker with. Papert provides numerous examples of children who, left to tinker with a problem, using the Turtle, will eventually arrive at an understanding that is satisfying.

Another powerful idea is "debugging". The traditional idea that there is a right answer, and the corollary that there is always the possibility of failure, no longer applies. If the Turtle does not draw what the child expected it to, it means that there is a "bug" in the programme that has to be found, not that the child has failed. Debugging in a sense that goes far beyond computer programmes is an essential part of learning anything. In the LOGO environment, bugs are talked about among children, and with teachers. They are found and corrected by breaking procedures into smaller steps, and by "playing Turtle". In this way, children arrive at meaningful corrections to what they are trying to teach the Turtle, while at the same time learning a new type of thinking.

This is procedural thinking. Papert points out that "in our culture number is richly represented, systematic procedure is poorly represented", (p. 175). Programming the Turtle and debugging programmes encourage the development of a particular style of thinking by means of which people break procedures down into bite-size "modules". These modules are the essence of the LOGO language and modular thinking plays an important role in children's learning. Papert claims that it is frequently advantageous for people to think in this way like a computer. This may put a lot of people off. But it is not really dehumanizing if you accept Papert's definition of computer literacy as knowing when it is appropriate to think like a computer. The net result is that in a computer culture, people might become systematic before they become quantitative.

These are but a few of the ideas that make *Mindstorms* such an important book. The computer is presented as a tool that allows a new type of learning to occur. And as Papert states, Mathematics is not the only domain of application for these ideas. LOGO and the Turtle are limited in their potential by the technology of the 'seventies, when they were developed. They therefore serve more as a model for what education in the future might look like rather than offering a specific direction for future action. Certainly the future will feature computers prominently. And surely children will learn to think in different, perhaps computer-like ways. But what is really important about Papert's ideas is the breadth of his vision and the optimism that I, for one, detected on every page. Children are indeed born with a love of learning. They have to learn to dislike learning, and unfortunately that is what nearly always happens when learning is dissociated from the real world in which children live. Papert has provided us with a model for improving this situation. Given the present state of education, we ignore his ideas at our peril.

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Fox, Seymour, *Philosophy for Education* Humanities Press, 1983, 120 pp., \$9.95 (U.S.)

This is a collection of papers on the idea and ideals of liberal education written by a group of American and Israeli professors of philosophy and education of whom the best known to Canadian readers are Mortimer Adler, Thomas Green and Joseph Schwab. The papers were first presented during a 1977 conference sponsored by the Centre for the Study of Democratic Institutions located in California. The collection is dedicated to the late Robert Hutchins, the Centre's founder. Hutchins is probably best remembered for his tireless efforts as a teacher and university president to champion the cause of a liberal or general education as an individually worthwhile end in itself and as a condition of democratic living.