Logo: An Opportunity for Synthesis, Self-Control and Sharing

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Introduction

Logo is a computer language specifically designed for children. I am not implying that it is a "kiddie language" (Logo is suitable for graduate work in computing science) but rather that the syntax and the domains of inquiry are readily accessible to young children. Logo is successful with very young children (Lawlor 1985), with physically disabled students (Goldenberg 1979), with students with learning disabilities (Weir and Watt 1981), as well as with students in regular classrooms and in gifted programs (Carmichael et al. 1985).

What are some of the reasons for Logo's success? *Synthesis, self-control* and *sharing* (the three *Ss*), plus the teacher, are key factors in Logo's success.

Synthesis refers to the natural necessity to build on one's previous knowledge (the Piagetian concept of constructivism), using both real world knowledge as well as a growing understanding of the rules of the Logo language. Self-control flags the value of permitting the learner to have a substantial degree of autonomy in what tasks are set and in the method of approaching them. Sharing refers to the social context in which much Logo activity occurs. Students helping students and feeling good about it (and about themselves) are common features of many Logo settings (Carmichael et al. 1985).

Synthesis

I will discuss the nature of synthesis at two levels. After reviewing how the concept of synthesis fits into current psychological theory, I will show how synthesis can be applied to the situation of an individual facing his or her first exposure to Logo. The second subsection then shows how this theory might apply to the situation of an individual learner, faced with their first exposure to Logo.

Synthesis and Psychological Theory

The educational community owes an enormous debt of gratitude to a self-proclaimed non-educator: the Swiss psychologist-epistemologist Jean Piaget. When one hears Piaget's name, one immediately thinks of children and of stages. The first association is a good one, the latter misleading. His substantial contribution to current psychological perspectives was not the idea of stages (which suggests that development is discrete rather than continuous) but rather that of development. Development implies change and growth. The purpose of education is to facilitate development. Change and growth are our mandate.

Equilibration is the term used to describe the underlying process of mental development by which individuals organize their ideas into noncontradictory wholes. This process occurs through the complementary subprocesses of assimilation and accommodation. Because individuals draw heavily upon what they already know (their present cognitive structure), the label constructivism can be used to describe theoretical perspective.

Traditionally, developmental literature has treated only a particular subset of the total picture: cognitive development, physical development, social development, moral development and emotional development are all familiar terms. The thesis is that such exclusions or restrictions, while well intentioned (''let us control for all possible sources of variation except one, and then observe the effect of this one remaining factor''), are fundamentally misguided. The resulting information is misleading because individuals never find themselves in such controlled situations outside of the research environment. Classroom practices or curriculum guidelines that fail to take this natural complexity into account are inappropriate.

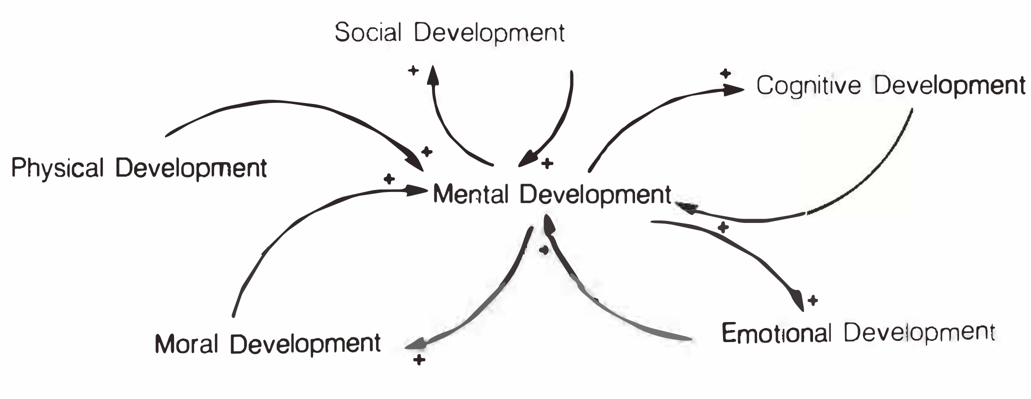
Figure 1 illustrates the interaction between mental development and other developmental factors. The arrows indicate a posited causal effect. Thus an increase in emotional development causes an increase in mental development. Similarly, an increase in mental development causes an increase in emotional development. The positive signs beside each arrowhead indicate that the relationship between the two nodes is in the same direction (for example, an increase in one causes an increase in the other, or a decrease in one causes a decrease in the other). Second, a distinction is made between mental development and cognitive development. The intention is to distinguish between overall mental development, which might include feelings and intuitions, and the more restrictive conceptual domain of cognitive development. The charting conventions follow those outlined by Roberts et al. 1983.

The psychological literature of the last decade has increasingly focused on cognitive approaches and the literature on learning emphasized individual's building upon their previous knowledge and experience. The cognitive emphasis has also expanded to encompass not only strict rational and logical perspectives but also emotional, affective and social components. Psychology is becoming both more holistic and more philosophic (for example, is knowledge constructed or discovered?) as professionals (for example, Solomon 1986) begin to reflect on the conceptual underpinnings of many of their ideas.

In addition to receiving contributions from philosophy, cognitive science (as the new discipline is called), has been strengthened by ideas from computing science. At first glance, this development seems remarkable, since one field is concerned with human ideas and nature while the other is ostensibly interested in machines and electricity. The term ''artificial intelligence'' is familiar to most people (Winston 1977; Haugeland 1985), and the term ''expert system'' is beginning to appear in the educational literature (Hayes-Roth et al. 1983; Van Horn 1986). However, lest the novice become enamored too quickly with these new ideas, cautionary notes have also appeared (Weizenbaum 1976; Dreyfus and Dreyfus 1986).

Thus cognitive science is practising what it preaches: the discipline itself is synthetic, building on any relevant bit of knowledge. One branch of computing, system dynamics, has taken the idea of modeling and simulation, combined it with the biological concepts of feedback and used the idea to construct conceptual as well as computer-based

Figure 1. Causal Loop



models of phenomena. One of the first applications of this approach to reach the public's attention was the Club of Rome's famous publication *Limits to Growth* (Meadows et al. 1972), which attempted to construct a model of the world showing interactions among population, agriculture, industry, pollution and natural resources. The same approach clarified the complexities of mental development. Diagrams and models should not be viewed as right or wrong but as appropriate or inappropriate for a given purpose or function. As the function changes, so may the model. Thus the previous model is explicated to reveal various kinds and interactions of development.

Synthesis in the Individual Learner

Figures 2, 3 and 4 illustrate a particular perspective on learning.

Figure 2

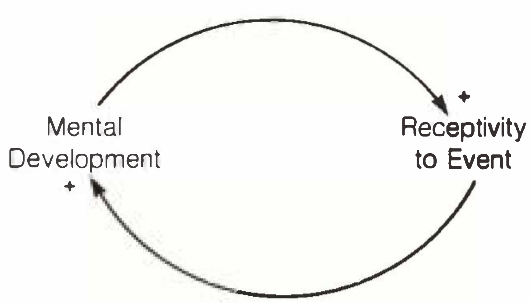


Figure 2 shows how a person's knowledge is positively related to the individual's receptivity to new events, which in turn is positively related to their knowledge. The net effect is a "constructive circle" in which learning begets more learning. "Receptivity to an event" is closely related to Vygotsky's (1962, 1978) concept of "zone of proximal development."

Both nodes clearly require amplification, and new nodes and causal arrows need to be identified. One might assume that knowledge consists of knowledge about using computers and about the specific language of Logo, as well as "other Knowledge" that may have a bearing on the present situation. The Other Knowledge may be very important. Existing knowledge about Logo may be zero: the individual may never have heard or seen it before. Existing knowledge about computers is not likely to be zero (most people have at least heard of them and have seen pictures of them) but it may be very limited (the person may not have actually touched one or watched someone else use one). (See Figure 3.)

We now have three knowledge nodes or "containers," plus one receptivity node. Thus the Logo node contains the amount of Logo knowledge that the user brings to the task (assumed to be zero). We now insert a brief exogenous variable: the instructional event. This event consists of a brief demonstration of the Logo commands "FORWARD" and "RIGHT."

An alternative representation may place more focus on the centrality of the Logo experiences. Consider Figure 4.

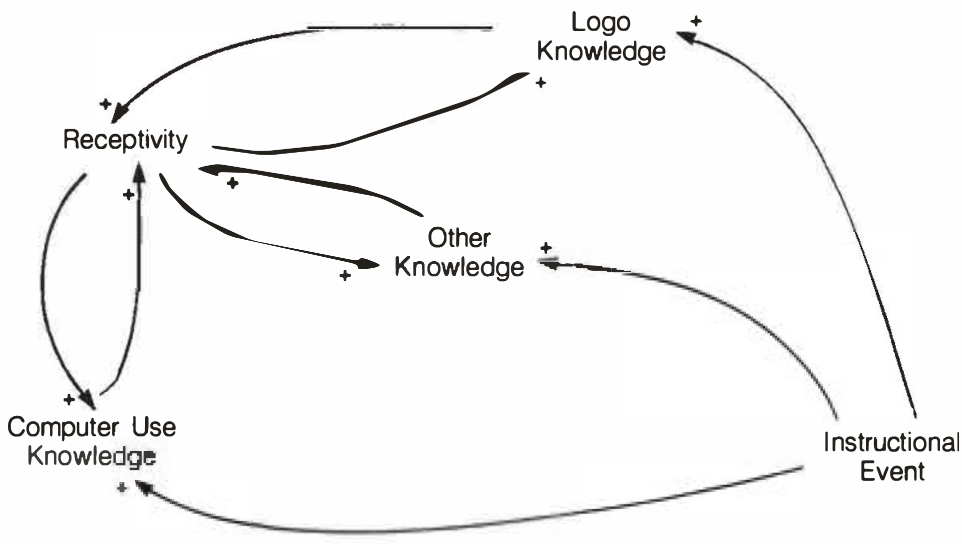
The effectiveness of this instruction depends upon (1) what the student already knows, (2) the student's attitude toward Logo and (3) the student's generic ability to learn. All three factors are "within the student." External factors include (1) the teacher's attitude toward Logo, (2) the teacher's attitude toward the student, (3) the teacher's understanding of Logo and (4) the actual instructional sequence. The addition of these nodes further complicates the situation, but the nodes may be important. Constructing a pleasing diagram is less important than constructing an adequate explanation.

Clearly, the effectiveness of instruction should not be viewed as a simple topic. We immediately realize that instruction is enhanced when

1. students can relate the instruction to what they already know,
2. students are positively disposed toward the topic,
3. students are positively disposed toward learning,
4. teachers are positively disposed toward the topic,
5. teachers are positively disposed toward the student,
6. teachers have a firm understanding of the topic, and
7. the instructional sequence takes the above into account.

The preceding summary is important not because it is particularly novel or complex but because it permits us to grasp the nature of the complexity "at a glance." Many people will consider the model incomplete, but additional information can be added. Another difficulty with the above approach is the ease with which we can construct alternative representations with little basis for choosing among them. Then

Figure 3



again, it may be that the alternative representations are equally appropriate.

Let us consider some of the details that might indicate that the first experience with Logo will be successful. First, the chances are quite good that novices (preschoolers or adults) will relate the commands FORWARD and RIGHT to their existing real-world experience of moving about. Indeed, this approach is no accident and was specifically built into the design of the original Logo. Drawing is also an early experience for virtually all children. The particular terminology and certainly the syntax may be new, but the general context should strike a responsive chord in most learners. Thus the first condition is likely to be met, at least to some degree. However, the student's initial attitude toward Logo is more difficult to estimate and is likely related to whatever attitudes the student may possess regarding computers. Attitudes may be positive, negative or neutral. A strongly negative attitude may well affect the outcome. The student's attitude toward learning is also important. A positive attitude ("learning something new is fun") is a substantial asset; on the other hand, a negative attitude ("school is boring") is a handicap. With young children, all three factors are often positive, perhaps explaining the level of success of introducing young children to Logo.

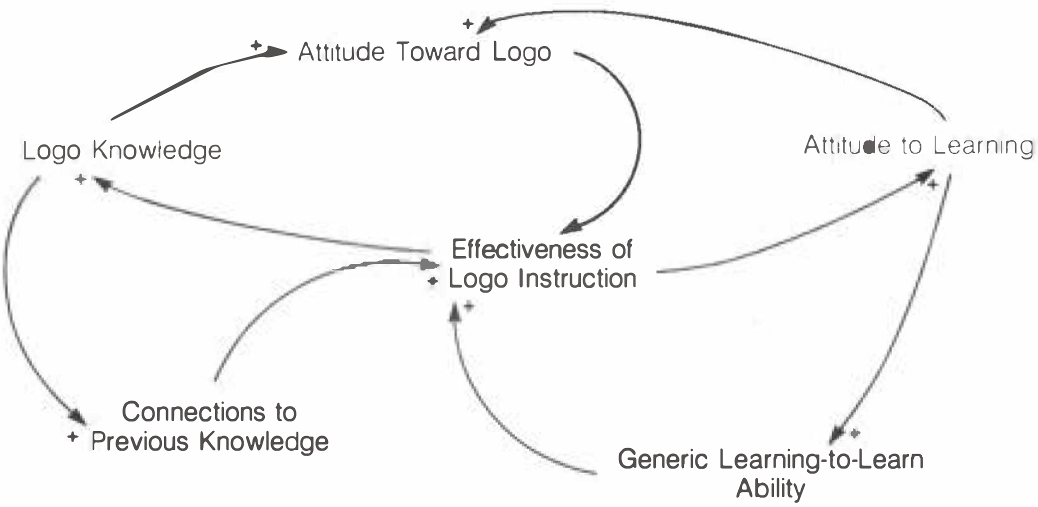
Three teacher factors were also identified. The teacher's attitude toward Logo is important. A skeptical or negative rating may be a powerful determiner of the outcome. We should not assume that the computer or Logo is a positive enough factor to compensate for a teacher who does not believe in using it. Similarly, teacher attitudes toward particular students should not be ignored. Sometimes teachers may feel that they are teaching the whole class, but this is not the case. Students filter the information as though it were directed at them. If previous events indicate that the teacher does not respect or value a particular student or students, then the teacher's impact is diminished, if not eliminated. A lesson that "looks good on videotape" may be entirely negated by an event that occurred two weeks earlier in the classroom.

The teacher's understanding of Logo is also important. Teaching a subject that one does not understand is indeed difficult; this applies to Logo. Finally, the particular instructional sequence is important and will be discussed later.

Self-Control

I have already acknowledged the contributions of Jean Piaget: I will now do the same for Carl Rogers. Although Rogers has written many books, I will quote from one, *Freedom to Learn for the Eighties.* The introduction contains this statement:

Figure 4



> It [the book] appears in a peculiar time in our history when many are saying that we must teach only the "basics," that we must tell children what is right and wrong, that we must teach them to obey and follow. . . . They hold that students are in school to be taught, not to discuss problems or make choices. (Rogers 1983, 1–2)

Rogers (1983, 18) states that "the primary task of the teacher is to permit the student to learn." He then distinguishes between meaningful learning and learning that has no personal meaning and only occurs "from the neck up." Rogers says that meaningful learning has five characteristics: it has a quality of personal involvement, is self-initiated, is pervasive, is evaluated by the learner, and has meaning as its essence.

Other authors have noted this distinction between meaningful and meaningless learning. I wish to highlight for a moment the second characteristic—that of self-initiation. Noss (1984) focused on the related issue of ownership. Either by design or by default, many students engaged in Logo activities have had opportunities to ask their own questions, to set their own tasks and to explore their own ideas. Such events are rare—a sad reflection of our present educational system. As a result, we have little information on what occurs in such situations. However, the findings of a number of studies in which this was allowed to occur (Watt 1979; Noss 1984; Lawlor 1985; Carmichael et al. 1985) all point in a positive direction.

Sharing

Maslow (1970) acknowledged the importance of sharing in his hierarchy of motives by placing it just after basic physiological and safety needs. Yet, my experience shows that most educators view Maslow's hierarchy as something to be memorized for a psychology exam rather than as something to consider in designing the curriculum. The Logo community may, in part, be responsible for resurrecting the idea of sharing. As a result, many of the exciting events surrounding Logo experiences have a highly social flavor to them. Researchers gathering data on this dimension are impressed by its richness (Carmichael 1985). Others have failed to look for it, have not noticed it or have set up an environment to prevent it from happening (since it might contaminate the results).

The issue has broader implications. What is the role of sharing in the school environment? What are the relationships between sharing and individualized instruction and cheating? How much of the school curriculum explicitly gives students an opportunity to share? If this number is low, then why would we expect our graduates to be adept at sharing or working together? The potential for sharing occurs at many levels as well: there can be sharing among classmates working on the same task. There can be sharing among students of different classes or grade levels. For example, Grade 6 students could work with Grade 3 students, or gifted students could work with students with learning disabilities. It is naive to assume that the primary domain of learning is at the level of the subject matter. Finally, there is the sharing between student and teacher. One of my favorite anecdotes from Papert's *Mindstorms* is that of a student who, working with his teacher on a problem, suddenly says, "You mean you really don't know!"

Teacher

What is the primary function of education and what is the role of the teacher in facilitating this function? The first question is dangerous because it appears to imply a single answer. Perhaps a more appropriate question is "What are some of the principal functions of education?" This question at least leaves the door open for new ideas that may have been missed in an earlier formulation. One such idea is "learning how to learn." Novak and Gowin (1984) asked "How can we help individuals to reflect upon their experiences and to construct new, more powerful meanings?" (p. xi). They go on to say:

> Whereas training programs can lead to desired behaviors such as answering math problems or spelling correctly, educational programs should provide learners with the basis for understanding why and how new knowledge is related to what they already know. . . . (p. xi)

Perhaps we have passed through an era when American behavioristic perspectives have held sway (What can students do? What are your behavioral objectives? What are the scores on standardized tests?) and are entering an era, also with a strong American flavor, when we ask "What do students understand?" The difference in perspectives is fundamental. Unfortunately, much of our current practice is based on a perspective that may be outmoded philosophically, psychologically and educationally.

The shift toward understanding is not as simple as learning a new instructional technique. What is

learning? How do students learn? What is the proper relationship of teacher to student? Alternative teacher roles vie for attention: distributor of facts, organizer of drill programs and seatwork, facilitator, encourager, and fellow explorer.

The teacher has an important role to play. For example, it is an error to assume that the synthesis within the mind of a student first exposed to Logo occurs naturally and spontaneously. The teacher can facilitate learning by bringing some of these potential connections into explicit awareness. Thus FD 100 may be related to FD 50 or to BK 100 or to FD-100. Relationships to movement commands in English or to another language may be observed. How would you tell someone from Japan to go forward? How would you tell Logo turtle to go forward? Exploring relationships among numbers may provide an excellent introduction to mathematics and the relative magnitudes of different numbers. Turtle steps and metric units may be viewed as analogous. How would you tell a robot to go forward? Now the class can discuss robotics for a while.

Connections abound. The secret is to look for them. Another example of looking for connections occurs at the meta level of problem solving when the teacher suggests that a student "play turtle" in order to figure out how to draw a particular figure with a sequence of Logo commands. Other suggestions such as breaking a complex problem into a number of simpler subproblems or developing an overall structure to the solution can be related to other non-Logo activities such as writing a term paper, baking a cake or studying for a history exam.

The teacher should be aware of numerous potential connections: the relating of Logo commands to one another, the relating of Logo to other non-Logo environments, the relating of Logo problem solving to generic problem solving. Everyone should be alert for connections between the specific situation and other knowledge. As a result, the student should see that learning Logo is much like learning anything else. The synthesis should include not only low-level activities such as learning how to use Logo language, but higher meta-level activities such as debugging, planning, organizing, problem solving, attitude awareness, communicating and sharing approaches and strategies. The basics of education may be at the other end of the continuum from where we have been looking. It may be very difficult to show some of these connections empirically. That does not necessarily mean they do not exist but that our current research procedures are at fault.

Education also benefits from a little faith. On the other hand, researchers must continue their efforts to provide further insights into our understanding of the learning process.

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