get's (1971) investigations. The verbalizations regarding tides and ves also tended to indicate the influence of experiential factors. The arest evidence for the influence of cultural beliefs on animistic thinking s seen in the children's conceptions regarding the living–dead dichot- y of lava. A number of children even stated that the living aspect of a was directly attributable to a traditional Hawaiian goddess.

Certainly, any investigation of animistic cognition would have to incor- rate the cultural and experientially based beliefs of the population died. To exclude these important factors would be to exclude powerful luences that underlie, and contribute to, children's conception and derstanding of the world around them.

From D. Wagner & H. Stevenson (Eds.), Cultural perspectives on child development (pp. 181-207). San Francisco: Freeman, 1982.

9

Cognitive Aspects of Informal Education

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Jean Lave

INFORMAL AND FORMAL EDUCATION COMPARED

In recent years anthropologists and cognitive psychologists have turned up as associates in the study of "informal education" because of a common interest in culture and its relation to cognition. In the field of psychology (as in the culture at large) the terms *school* and *formal education* long served as descriptors of those institutions that we think of as "education." But as anthropologists and psychologists expanded their research to include other cultures, the terms that were adequate in this culture were not appropriate descriptions of educational institutions in other cultures.

*This paper was an equal collaboration. A coin flip determined the order of the author's names.

Anthropologists have argued that all varieties of educational activities should be included in the educational domain, including much more than formal schooling. By this view, for example, apprenticeship to learn a craft or become a master navigator, is part of education. Learning to play pool by hanging around the pool room and practicing is part of education. Learning to sew, to play games, and even to master basic self-management skills in early childhood are informal educational experiences. Formal education includes other kinds of schools besides Western schools, including bush schools, Quranic schools and Sunday schools.

"Formal education" and "informal education," considered as two poles in a typology, have opposite characteristics. Our analysis draws on Lave (no date), Fortes (1938), Mead (for example, 1928, 1930, 1943), Cohen (1971), and Scribner and Cole (1973). The dichotomy shown in Table 9–1 has served a useful role in expanding our conceptualization of education beyond the boundaries of our own culture. But the distinction is an idealized one. Too often the dichotomy has been applied as if all forms of education in a culture could be described by one term—"culture *x* has informal education." But this is clearly overgeneralization. For example, in the Vai culture in Liberia, forms of education include Western-style schools, bush schools, Quranic schools, apprenticeship, training to farm, and tutorial transmission of a syllabic script. This and other examples also make it clear that educational formality is more a continuum than a pair of opposites. In addition, all societies in the world provide several different types of education to their members, and these types differ in how formal they are.

Let us contrast examples of formal and informal education from American culture. Formal schools in this culture are highly institutionalized: schooling takes place in special buildings, at times that take precedence over other activities and is conducted by special personnel, specially trained. Training is an end in itself—one learns to read, write, and do arithmetic in order to know how to read, write, and do arithmetic. The curriculum and principles for teaching are explicit and quite highly systematized.

In contrast, learning to cook takes place in the kitchen, a space designated for cooking activities but not explicitly for educational ones. The person who teaches cooking is probably doing so because he or she is a parent or older sibling, not because of prior attendance at a cooking school. The purpose of learning to cook is to be able to contribute to the family welfare, or to one's own. A person may learn by waiting expectantly in the kitchen when hungry, watching the cook of the day, and helping out by chopping things or setting the table. What is learned is

Table 9–1 *Some Idealized Characteristics of Informal and Formal Education*

INFORMAL EDUCATION	FORMAL EDUCATION
1. Embedded in daily life activities.	1. Set apart from the context of everyday life.
2. Learner is responsible for obtaining knowledge and skill.	2. Teacher is responsible for imparting knowledge and skill.
3. Personal; relatives are appropriate teachers.	3. Impersonal; teachers should not be relatives.
4. Little or no explicit pedagogy or curriculum.	4. Explicit pedagogy and curriculum.
5. Maintenance of continuity and tradition are valued.	5. Change and discontinuity are valued.
6. Learning by observation and imitation.	6. Learning by verbal interchange, questioning.
7. Teaching by demonstration.	7. Teaching by verbal presentation of general principles.
8. Motivated by social contribution of novices and their participation in adult sphere.	8. Less strong social motivation.

probably as much influenced by menu plans and grocery specials as by considerations of which step or stage the apprentice cook is currently at. Also in this culture, people do not sit around at parties or at work discussing how to teach cooking.

Certain consequences should follow from these different sets of circumstances, according to the formal–informal analysis. When something is learned informally, the balance of responsibility for the transmission of knowledge is apparently tipped in the direction of the learner: There is little formal teaching, as learning is a by-product of activity that is primarily aimed at meal preparation. But the learner in informal learning situations is likely to be highly motivated, for several reasons. For one thing, all women, and more recently many men, in American culture are expected to know how to cook. If it is the learner's assumption, shared with relatives, friends, and neighbors, that the learner will of course learn *x*, the learner is likely to be highly motivated to learn, or at least not inhibited by choices, doubts, or questions about whether learning *x* is worthwhile.

A second source of motivation is the close relationship you are likely to have with your teacher, and the fact that learning often occurs in the

context of a one-to-one interaction. A third source of motivation is the social contribution that learners make in the course of learning. In the cooking example, cutting up the onions that go into the stew is a genuine contribution to the family dinner. In contrast, learning a multiplication table is not going to have immediate practical consequences for anybody. All the points made here about cooking in this culture have been made by anthropologists concerned with informal learning in other cultures.

One further contrast made by anthropologists is between culture transmission centered around the preservation of tradition and culture transmission oriented toward change and innovation. This is a very complex issue. If the subject matter is strongly valued and part of cultural tradition, we assume that great emphasis will be placed on exact learning of what is being taught, not on teaching the child to develop novel examples or new interpretations of old ideas. For example, we don't encourage children in Sunday school to make up new Bible-like stories or offer novel interpretations of them. Formal education in Western schools not only teaches new ways of doing things, but may also encourage cultural discontinuity and change because, like all other forms of education, it reflects cultural values.

The effects of "formalness" must be disentangled from the effects of cultural values. To do so, one must search for formal education in the context of traditional values or informal education in a cultural context that fosters change.

Anthropologists, and also psychologists, have taken the view that education in small, farming–craft cultures is mainly informal while education in large industrial cultures is mainly formal. The cooking example, above, illustrates the existence of informal education in a large industrial culture. Anthropologists and psychologists have often assumed that formal Western schools, when exported to countries where members of small societies can attend them, reflect Western values concerning tradition, change, and educational practices. But Gay and Cole (1967), as well as Erchak (1977), question this assumption, suggesting that values taught in Liberian schools may differ from those taught in American schools. Thus a value taught to Kpelle children in Liberia in informal educational situations—respect for authority—is also taught in school in that society. In parallel fashion, informal education in industrial countries may well differ from informal education in small farming–craft cultures in manifesting characteristics of school-based learning. It is our view that more empirical research needs to be done to establish the characteristics of each educational situation.

EDUCATIONAL PROCESSES AND THEIR COGNITIVE CONSEQUENCES

Hypotheses about the impact of the two idealized poles of educational formality on cognitive skills have focused on the role of teaching–learning techniques in shaping cognitive skills and on the role of learner motivation. Among teaching–learning techniques, the role of language in instruction and learning has received special emphasis.

We know very little about the diverse educational experiences that are supposed to lead children to different approaches to cognitive tasks. One clear indicator of our ignorance is the practice of contrasting schooled to nonschooled subjects in experiments. "Nonschooled" covers a variety of types of education of different degrees of formality for different subjects, but these types are generally not specified. The picture produced by experimental investigation is one in which schooled experimental subjects in cultures around the world are usually more successful than unschooled subjects on experimental tasks. In general, subjects who have been to school are more likely to generalize from one experimental problem to the next and more likely to formulate general rules to explain their answers (Scribner and Cole, 1973).

Learner Motivation and Instructional Techniques

These positive effects of formal schooling are especially interesting since, in comparisons of the idealized modes of teaching, informal learning and teaching strategies look much more effective than formal ones. One commonly accepted rule of good education is that active learning is more successful than passive learning. Anthropologists have documented cooperation and participation as of great importance in informal learning (for example, Fortes, 1938; Hogbin, 1946; Read, 1960). If cooperative participation is a major part of the learning process, informal education should have strong effects. Participation in daily activities that involve use of skills is both a good teaching–learning technique and highly motivating to the learner. Such opportunities are, however, rare in school. Thus it is quite puzzling why informal education doesn't appear to have more powerful effects than formal education on cognitive performances in experimental contexts.

The apparent superiority of school-based performances is to some extent an artifact of cross-cultural experimental design (Cole, Sharp, and

Lave, 1976). Cole and colleagues argue that the tasks used in cross-cultural research on the effects of schooling tend to be drawn from Binet and others, who were seeking tasks that would be good predictors of school performance. Thus school children will perform better on these tasks as a result of their greater familiarity with them, not because school is a more effective form of education.

On the other hand, Scribner and Cole's (1978) research among the Vai in Liberia showed that literacy acquired in a Western-style school produced skilled performance on a wider variety of tasks, including unfamiliar ones, than literacy acquired either informally or in a Quranic school. The problem of course is to distinguish between two sources of skilled performance: on the one hand, schooling as a social institution, and on the other, literacy learning in school.

This research opens the possibility that differences in performance are due to differences in teaching and learning techniques. A study by Kaye and Giannino (1978), focusing on the strengths and weaknesses of imitative and observational learning, illustrates the possibility. Their study compared three methods of teaching 8-year-old boys and adult males how to open a puzzle box: trial and error, verbal shaping ("you're getting warmer/colder"), and simple demonstration. The box opened when the subject pushed a certain button on each side. A transfer task involved an identical-looking box that opened when the subject pushed a button on the front. The demonstration–observation method produced the most effective original learning but the least successful transfer to a new situation. In other words, successful imitation of a demonstration led to perseveration of the method even where it was ineffective. Thus education that relies heavily on observation and imitation by the learner may be the most effective way to teach a given task but the least effective for transfer to a new task. Trial-and-error learning, with or without verbal shaping, may have the opposite pattern of strengths and weaknesses.

The Role of Language

Earlier thinking about the instructional role of language has tended to treat formal and informal education as dichotomous. On the one hand, people have argued for the special importance of verbal channels of communication in schools (for example, Bruner, 1964). Others have emphasized the comparative lack of verbal instruction and verbal learning in informal educational settings (for example, Cazden and John, 1971). Let us consider this second point here, for the analysis of interaction in school is beyond the scope of this chapter. Informal learning is supposed

to involve demonstration by the teacher and observation by the learner, followed by cooperative participation. This method is possible because the learner has ready access to situations in which skilled adults are carrying out the activities being learned. With such intimate knowledge of what is to be learned, the rationale goes, teachers need provide little or no verbal explanation or direction in order for the child to understand.

Before reaching a general conclusion about the role of verbalization in informal education, it is necessary to separate out different formal and functional types of speech acts. It is also necessary to consider learner and teacher separately in approaching this question.

Commands seem to be important in informal education in pastoral and agricultural societies where children perform important economic tasks at a young age (Munroe and Munroe, 1972, 1975; Whiting and Whiting, 1975; Kirk, 1976; Harkness and Super, 1977). Positive commands become relatively rarer in the city, where the opportunities for children to perform important household chores decline (Graves, 1968). Often present with frequent commands in such societies is the high value placed on obedience (LeVine, 1963). In terms of language skills, obeying commands requires the development of comprehension rather than production skills, and may in fact be antithetical to an emphasis on self-expression (Harkness and Super, 1977). That is, verbal expression in response to a command often means a delay in carrying it out or, even worse from the point of view of obedience, the questioning of the command itself.

Whereas the use of explanation on the part of teachers seems to vary within small traditional cultures, questioning on the part of learners seems quite rare (Erchak, 1977; Fortes, 1938; Goody, 1980; Hogbin, 1946; Peshkin, 1972). For example, Kpelle parents in Liberia consider the asking of questions by children to be a very negative trait (Erchak, 1977). In terms of actual practice, Goody observed a very low rate of question asking by novice Gonja weavers in Ghana. Goody concludes that questioning may carry an implied challenge to the person questioned and that such challenges would be highly inappropriate from a low-status person (child, novice) to a higher-status person (adult, master). It is not clear how the rate of asking questions by unschooled novice weavers compares to the rate among Gonja children who attend Western-style schools. There is, however, evidence from Kenya that when mothers shift toward modern values they place greater value on the active encouragement of their 2- and 3-year-old children's language development (Harkness, 1975). The traditional Kipsigis socialization process encourages silence when in the presence of older or higher-status people (Harkness

and Super, 1977). The more modern mothers also tended to be less dominant with their young children, and the children of less dominant mothers asked significantly more questions (Harkness, 1975). Hence, personal modernization on the part of mothers may lead, indirectly, to more active questioning on the part of children. Harkness is careful to point out, however, that more modern values are not necessarily associated with more education in the particular Kipsigis community where she worked. However, in a Maya Indian community in highland Guatemala, Rogoff (1977) found that mothers with more education, as well as mothers with more modern practices, used verbalization more and demonstration less in teaching their 9-year-old children to make a tinker-toy construction.

School is presumed to use verbal communication as the primary mode of teacher–learner communication because school activities are supposedly removed from the context of daily activities, and hence much of what is being taught is not present in the learning situation. It is on these assumed differences in verbal communication that psychologists have focused attempts to account for experimental performance differences between schooled and nonschooled subjects. But why should the use of language make such an enormous difference in cognitive performance? First of all, teachers may model verbal explanatory activity and encourage it on the part of learners. Also, Bruner (1964) argues that removing the learning situation from the situations of daily life (which school is assumed to do) makes it possible for learning to become an end in itself rather than a means to accomplish some practical activity. This separation from practical activity means that learning takes place more exclusively through language and symbolic activity. Yet it is clear to psychologists as well as to anthropologists that the language used by normal adults in all cultures requires fully developed language capabilities. Realization of this state of affairs has led to reformulations of the contrast between the use of language in informal and formal education situations in terms of degree of use of different modes of communication.

Our view is that it is insufficient merely to consider the amount of language; it is also necessary to consider the structure of its use. For example, the results of an empirical study of the development of concept formation in Senegal (Greenfield, Reich, and Olver, 1966; Greenfield, 1972) show how language use can vary as a result of formal schooling. In response to questions about why they had selected certain pictures or objects as most alike, unschooled (illiterate) Wolof children gave verbal reasons that were less redundant with their nonverbal communication than their schooled (and literate) peers. (Both groups were interviewed in Wolof, their first language, not French, the language of the school.)

For example, if a typical unschooled child grouped all the red objects together, he or she might well answer the question "Why?" by pointing to each object and repeating the Wolof word for "red." The typical school child, even from the same village, might well also point to each object in turn, but would also redundantly express the pointing gestures in a linguistic form, saying *"This one* is red; *this one* is red" and so on. While this research was not able to separate literacy effects from schooling effects, it is clear that unschooled children formed communications involving the nonredundant integration of linguistic and nonverbal elements, while school children used language more, even when it was redundant with nonverbally presented information.

THE IMPACT OF INFORMALLY LEARNED PRACTICAL SKILLS ON COGNITIVE PERFORMANCE

Having discussed theoretical speculations about the ways in which different forms of education might affect the development of cognitive skills, we turn now to empirical research on relations between education and skills. We will concentrate here on informally learned skills.

Piagetian conservation tasks form a major part of the literature on relations between informal learning and skill attainment. But these studies (for example, Price-Williams, Gordon, and Ramirez 1967, 1969; Greenfield and Childs 1972, 1977; Adjei, 1977; Steinberg and Dunn, 1976; Harkness and Super, 1977; Durojaiye, 1972) investigate the effect of informally learned technical skills on performance in tasks that originated outside the cultures in question. There are very few studies in which a cognitive test has been generated from an analysis of a particular skill found in a given culture. The first such instance of this strategy occurs in Gay and Cole's (1967) research on the Kpelle of Liberia. Gay and Cole looked at the effect of rice farming, the central Kpelle subsistence activity for both men and women, on test performance in estimating quantities of rice. They compared illiterate Kpelle adults, Kpelle school children, American adults with little schooling, and American college graduate Peace Corps volunteers in training for service as teachers in Liberia. The illiterate Kpelle adults were by far the most accurate in their estimations, thus reflecting their extensive experience in measuring rice as it progresses in the cycle from farm to meal. Clearly, the cognitive test of rice estimation is closer in structure and materials to a frequently met technique in Kpelle life than the tests used in other studies. And the test

superiority of the people who use this technique in everyday life is correspondingly greater than has been found in other studies. We take these findings as important guides for designing cross-cultural studies.

Empirical Investigation of Zinacanteco Weavers

We began the work to be described here in order to test some of the prevailing ideas about the effects of informal learning on cognitive skills. And since much of the discussion revolves around the ability of different forms of education to produce generalized learning skills, both research efforts focused on the generalization of familiar skills to unfamiliar problems.

In Greenfield and Childs' (1977) work with girls learning to weave in an Indian village in Chiapas, Mexico, and Lave's (1977a, 1977b, no date) work on apprenticeship among tribal tailors in Liberia, we used very similar approaches. (This was no accident, since Lave drew on Greenfield and Childs' work in designing experiments in Liberia.) We both looked for subjects who displayed a range of school experience and a range of craft experience, and asked them to solve a set of problems that varied in degree of similarity to the situation in which they learned weaving or tailoring. The results were then analyzed to see whether skills used in weaving or tailoring tasks were used to solve unfamiliar problems.

Both of us found that it was necessary to spend many hours observing weavers or tailors at work, and both of us learned some of the craft skills ourselves before trying to design a series of problems that might appropriately tap both these learning experiences and the skills that might plausibly be expected to develop from them.

Greenfield and Childs worked in a highland Mayan village of Tzotzil-speaking Zinacanteco Indians near San Cristobal de las Casas in Chiapas, Mexico. With a population of about 8000, the Indians live in a typical Mayan settlement pattern: dispersed in small farming villages away from a central town, which is heavily populated only during the times of year when there are major religious festivals. These festivals are based on a syncretic religious practice combining Mayan and Catholic beliefs and rituals. The major crops are corn and beans, some raised for sale, and the major occupation is farming. Women do all the weaving, every adult woman being a competent producer of clothing. In all cases weaving is necessary to clothe one's family. Almost all clothing is hand woven, and weaving is therefore a frequent and important activity. Weaving is a sociable activity that takes place often in the late afternoon when other chores are done. Children thus have open access to weaving activities

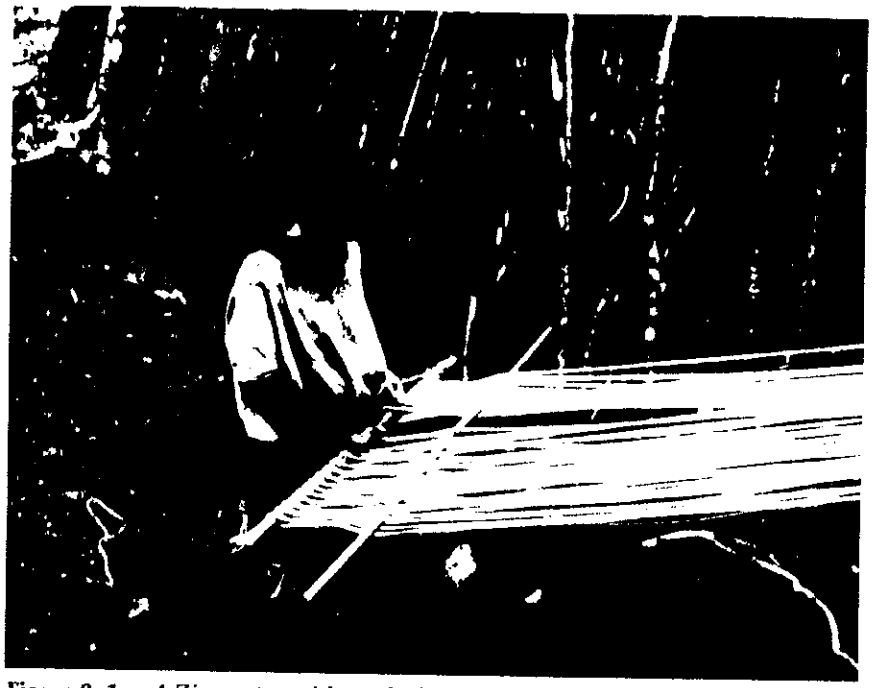

Figure 9–1 *A Zinacanteco girl uses backstrap loom when first introduced to weaving.*

and observe a great deal of it. Weaving is carried out on a backstrap loom. One end of the loom is fastened to something rigid, such as a pole or tree, and the other end to the weaver, who maintains the tension in the warp threads by leaning back against the backstrap. By this process two types of cotton cloth are made, each with a different red-and-white striped pattern. In addition, a heavier type of cotton and wool cloth is made for wear in cold, rainy weather.

In Greenfield and Childs' sample, beginning weavers ranged from 8 to 11 years of age. Before they learn to weave they learn the simpler tasks of boiling warp threads and dyeing wool. After they learn to weave they still must learn to wind the warp threads and spin. By the time a Zinacanteco girl reaches the age of 13 or 14 she is able to do the work by herself.

To find out whether weavers can generalize their weaving skills to unfamiliar problems, Greenfield and Childs presented the weavers with a series of problems. Carefully designed sequences of problems are required in order to draw even tentative conclusions about subjects' abilities to apply skills learned in one situation to solve unfamiliar problems.

The researcher's first task, a complex one, is to design problems that gradually get more and more distant from the problem-solving require-

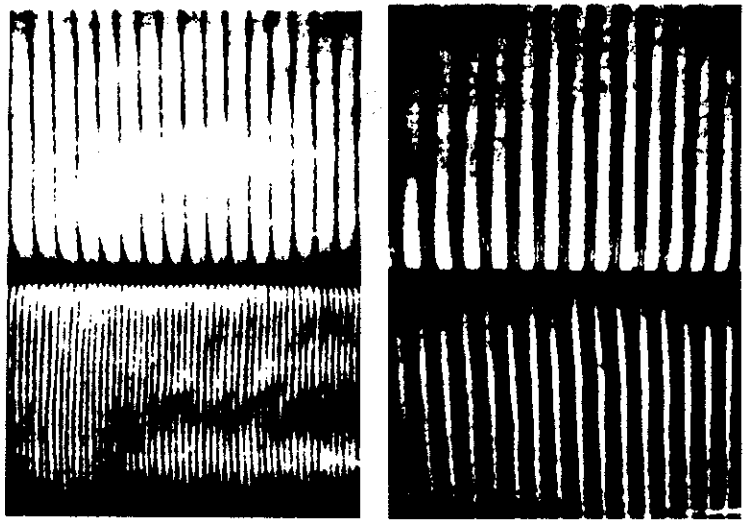

Figure 9–2 *The Zinacanteco woven patterns used in the experimental study.*

ments found in the everyday environment. Another difficult task in trying to assess cognitive consequences of everyday experiences experimentally is to characterize the cognitive skills used in the course of carrying out a given activity.

Experimental cognitive psychologists have recognized the importance of designing tasks that will minimize the variety of kinds of mental operations engaged by the task, so as to explore the cognitive characteristics of particular kinds of skills. Short-term memory or clustering in recall might be examples.* But we have chosen to focus on questions concerning the variety of skills brought to bear (or not) in the situations in which they are used in daily life, rather than on the nature of particular cognitive skills. It is partly this difference in research questions that led us to choose as the target skill "ability to generalize from familiar to unfamiliar problem-solving situations." This covers a large range of unspecified component skills rather than focusing on one of those skills. Greenfield and Childs' (1972, 1977) experiments with weavers in Chiapas, Mexico, illustrate this approach.

Greenfield and Childs presented the weavers with a series of pattern-

*Even tasks involving few cognitive operations can be influenced by education and other cultural factors. Wagner (1978) has interesting data from Morocco showing the impact of schooling, rural environment, and the occupation of rug selling on recognition memory for photographs of Oriental rugs (see also Chapter 5, this volume).

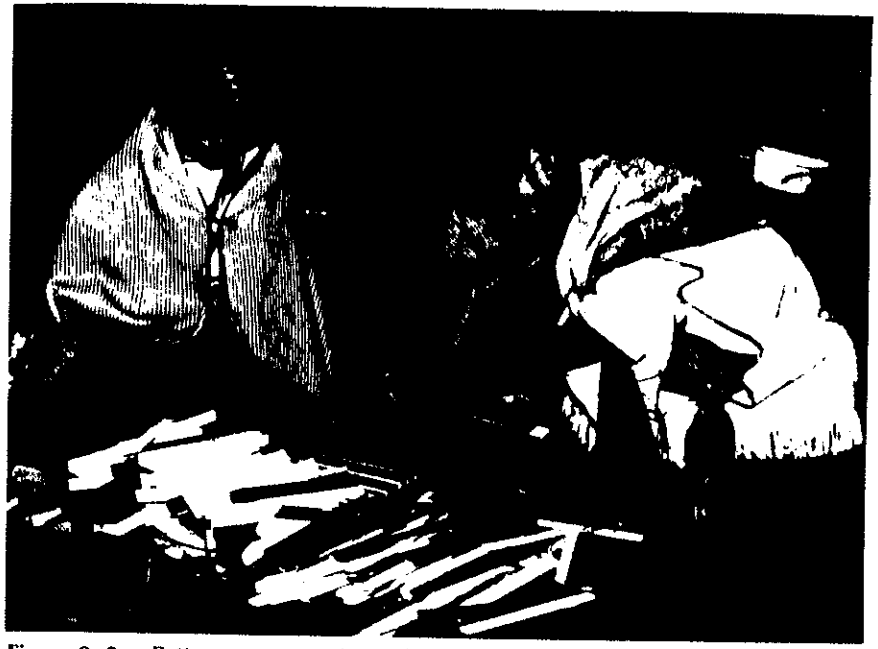

Figure 9–3 *Pattern representation task used with Zinacanteco children.*

representation and pattern-completion problems. First the weavers were asked to represent the familiar red-and-white striped cotton patterns of woven garments, but using wooden sticks in a frame to construct the designs. Pink and orange sticks were available, in addition to red and white. There were interesting differences between the female weavers and a group of Zinacanteco boys who did not know how to weave. By accurately representing the colors and the configurations of the two patterns, a substantial proportion of the girls used the sticks to represent the patterns as they are actually constructed with threads. In contrast, the boys generally used the sticks to represent the finished visual impression created by the garments at a distance, violating pattern configurations and even colors in the process. These results suggest that the weavers' knowledge of how woven patterns are constructed in Zinacantan affected their approach to representing the patterns in an unfamiliar medium.

Another interesting finding concerned the pattern-completion problems, where children were asked not just to represent familiar patterns but to continue novel patterns the experimenter had started. An example of this task might be a sequence of sticks that consisted of one white and one red, then one white and two reds. After two more repetitions, the

subjects were asked to complete the pattern as it had been started. On these unfamiliar patterns, the nonweaving boys performed significantly better than the weaving girls, but there was not a significant difference between boys who had been to school and those who had not. (Because all Zinacanteco girls learn to weave, it was not possible to test a group of nonweaving girls of comparable age.) It suggests that the relevant educational experiences of the boys may be found in their preparation for the adult male role, a role that includes participation in the monetary economy beyond Zinacantan. This preparation includes trips to urban Mexican centers such as San Cristobal de las Casas and Tuxtla Gutierrez, where patterned fabric is not restricted to three major designs, as it is in Zinacantan. Thus boys have much greater opportunity than girls to observe varied cloth patterns, including the striped ones particularly pertinent to the experiment. The weavers' pattern skills do not seem to transfer to tasks involving novel, unfamiliar patterns. This fact is understandable when one considers that patterns are not among the things that Zinacantecos feel free to change or be innovative about.

But schooling did make a difference in representing the familiar woven patterns. The school boys, none of whom had weaving experience, resembled the weavers and differed from their unschooled age-mates: they too used the sticks as if they represented threads, maintaining the basic pattern configurations in their constructions. This was an unanticipated result, and we can only speculate about its cause. One possible explanation relates not to experience with patterns but to a more general skill: translation from one medium to another. The pattern-representation task differed from the continuations in requiring that a pattern existing in one medium (cloth) be represented in another (wood). It may be that Western schooling introduces this experience into an oral culture, for reading and writing involve translation between auditory and visual media.

In sum, in a situation quite different from the everyday context in which weaving takes place, that is, in a one-to-one relationship with an experimenter and using unfamiliar materials, the weavers are successful in generalizing their analytical skills in representing culturally defined woven patterns, a familiar task, but are not as successful as nonweavers in continuing novel patterns, an unfamiliar task. Since pattern continuation is in fact one type of pattern-representation task, this configuration of results suggests the possibility that generalization of an informally learned craft skill from everyday to new problem-solving situations is rather limited. On the other hand, it was also found that schooling, independent of weaving, had an influence on the pattern-representation task, perhaps because it involved translation from one medium to another. Here we see that more than one type of experience and more than one type of cognitive skill is relevant to a given task, a situation we shall meet again in Lave's data.

Effects of Tailoring on Mathematical Skills

Lave conducted her study in the tailors' alley at the edge of the commercial district of Monrovia, the capital of Liberia. Here 250 master and apprentice tailors, most of them from the Vai and Gola tribes, ply their trade and learn their craft. After several months of observing in the shops, a set of four tasks was devised. The tasks were concerned with arithmetic skills. The problems the tailors were asked to solve ranged from very familiar to quite unfamiliar. The first task was to estimate the size, in inches, of the waistband of pairs of trousers, followed by size estimation of loops and strings, lengths of string, and finally sticks of wood. Some of the sizes were familiar ones, frequently encountered in the course of making trousers. Others were not customary sizes. It was hypothesized that the less familiar the materials (wood, string), configurations (straight lines instead of loops) and the sizes, the greater the generalization required and the more difficult the problems would be for the tailors.

The second task involved extrapolating an arithmetic function. The tailors associate certain hip and fly-length sizes with particular waistband sizes. In the second set of problems the tailors were asked to estimate the appropriate hip and fly-lengths, given a particular waistband size. The waistband sizes included several very familiar ones but also some very small and some extra large. Here the task was a familiar one, with content that varied from familiar to unfamiliar.

The third task involved arithmetic concepts. Tailors were asked to recognize and read numbers, identify a variety of units on a measuring tape (such as inches, yards, half- and quarter-yards) and do simple addition, subtraction, multiplication, and division problems. Some of these problems involved familiar questions and typical numbers encountered in tailoring work. Others were unfamiliar to tailors.

The fourth task was a proportions-matching task. On a 4″ × 6″ card was a drawing of a pair of trousers. (The drawing style was borrowed from a tailor who often drew pictures of trousers.) A line divided this portion of the card from the rest. On the other part of the card were three drawings of trousers. The figures were drawn so that only one matched the waist to length proportions of the stimulus figure. The object was to decide which figure was most similar in proportions to the

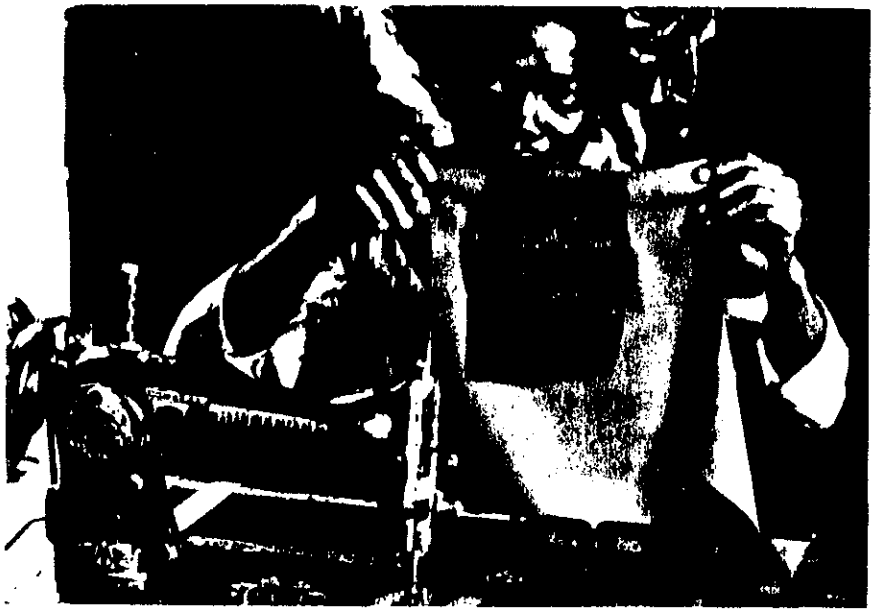

Figure 9–4 *A Liberian tailor.*

stimulus figure. Several demonstrations of the point and discussion with the tailors preceded the actual task. Three of the cards had drawings of trousers, and these were presumed to be most familiar to the tailors. Other cards had figures of squares, rectangles, triangles, trapezoids, and similar geometric figures.

Having decided on a framework for each experimental task, it was relatively easy to build sequences of problems that seemed on a priori grounds (and on the basis of months of observing and asking questions in tailor shops) to become progressively less familiar. It was also necessary, however, to consider the familiarity of the frameworks themselves, as well as the fact that many of the tailors and apprentices were going to school and had gone to school. To compare tailors with different amounts of schooling and different amounts of tailoring experience, it was also necessary to assess the familiarity of the experimental problems from the point of view of school problem-solving scenes as well as from the point of view of apprenticeship.

To assess the familiarity of problem frameworks, Lave first ranked the problems in terms of familiarity in the learning environment of the tailor shop, and then in terms of familiarity in the learning environment of school. Two of the tasks were very close to the form in which the same questions arise in the course of tailoring activity. Both the waistband

Figure 9–5 *A typical scene in a tailor quarter of Monrovia.*

estimation task and the extrapolation from waist size to hip and fly sizes are challenge games played by the tailors themselves. One tailor finishes a pair of trousers, tosses it to the master at the next machine and says, "How big do you think it is?" The other master holds the trousers up and makes a guess. The first master may disagree, and other tailors join in to make their own guesses. Finally someone takes a tape measure and finds out how big around the waistband actually is. As for hip and fly extrapolations from waistband size, it is again the individual tailor who has to make a guess and defend it on the basis of his own experience. Neither estimation nor extrapolation is taught in Liberian grade schools. Both of these tasks should be quite unfamiliar from the point of view of school experiences.

The proportions-matching task is related to tailor work in some ways but differs from it in others. First the similarities: Tailors make different sizes of the same garment. They are likely to pay attention to proportions, which usually should be invariant across garments of different sizes. Therefore tailors ought to perform well on an experimental task that involves noticing which two objects, irrespective of size, have the same proportions. In particular, since they make lots of trousers, trousers should be familiar content for tailors.

Now the differences: In the experimental task, pictures were drawn on cards rather than using actual trousers as in the waistband estimation task, or language, which is the customary medium of extrapolation

games. And the tailors were asked to choose which of three drawings with different proportions best matched a stimulus picture of a pair of trousers. Tailors do not routinely compare pairs of trousers to each other, examining their proportions. Nor are the tailors familiar with multiple-choice format. On the other hand, matching and multiple choice are characteristic school tasks, while comparing proportions is unfamiliar in the school context. In sum, from the point of view of tailoring, content is familiar and format unfamiliar, whereas the reverse is true from the point of view of school. Hence this task is relatively unfamiliar from both tailoring and school points of view.

In the fourth task, involving arithmetic operations, some problems were familiar from a tailoring point of view and others from a school point of view. This task involved some word problems, a very familiar format in school settings. On the other hand, some of the number-reading and doubling and halving problems involving waistbands and cuffs (circumference of trousers versus trousers laid flat on the table) were borrowed directly from tailors' questions to their apprentices. Within this frame, content was varied from typical trouser waist and cuff measurements to numbers approximately the same size, but ones that rarely come up in the course of making trousers.

Lave looked for frames in which the assumptions of the Vai and Gola tailors about the circumstances governing problem solving were approximately those to be encountered in the experimental situations. This is not to say that the experimental situation was thereby transformed into a native scene—far from it. But by "borrowing" situations from the daily activities of tailor shops and schools as the basis for testing the ability to apply past experience to a new problem, Lave hoped that the approximation to familiar scenes would be obvious to the tailors.

Statistical regression techniques were used to separate out the impact of tailoring experience (both specific tailoring skills and general tailoring experience) from the impact of school experience. The tailors and apprentices in the sample ranged from about 10 to about 40 years of age; from a few months of tailoring experience to 25 years; and from no schooling to 10 years of schooling.

The proportions-matching task, relatively unknown in either school or tailoring, was unaffected by either experience. The school-oriented arithmetic problems were affected by both tailoring experience and school experience, but more by the latter than the former. For tailoring-oriented arithmetic problems the reverse was true, and schooling contributed less than tailoring skills. For the estimation and extrapolation tasks, school had little or no effect and tailoring showed a major impact on the familiar problems; this effect decreased as the problem content (such as sizes and materials) became less familiar.

Conclusions from the research on tailors are two. First of all, when the experimental tasks are similar in form to the task that elicits those skills in daily settings, tailors and school pupils as well as weavers are able to bring their skills to bear on new problems and solve them successfully. Second, it appears that neither schooling nor tailoring skills generalize very far beyond the circumstances in which they are ordinarily applied. Thus, tailoring experience was not nearly as helpful in estimating the length of sticks of wood as in estimating the circumference of trouser waistbands. School, which had strong impact on word problems in arithmetic, had little impact on estimation, extrapolation, or proportions-matching tasks.

Tentatively, since there are few results on which to base conclusions, it seems that under some circumstances the ability to generalize cognitive skills to unfamiliar but related situations may be heavily constrained. It may well be that not only the familiarity of different task dimensions and problem-solving activity govern the ability to generalize, but also that integration of these dimensions in familiar ways is required.

The experimental work described in this chapter makes its contribution through exploring a little-used approach to comparative studies of the impact of educational experiences on cognitive skills. The more usual approach is to take tasks, most of which have been generated out of knowledge of school tasks and scenes, and administer them to people with different educational experiences. We have explored educational experiences other than school experiences and tried to devise tasks that were related to these other educational experiences in much the same way that most experimental tasks are relevant to school. The advantage of our strategy is that it allows us to directly assess some effects of non-school educational forms.

A CLOSER LOOK AT TEACHING AND LEARNING

It is not sufficient to interpret experimental results in terms of idealized descriptions of formal and informal education. If we are going to establish valid connections between particular forms of education and particular kinds of cognitive skills, a necessary part of the enterprise is to build detailed descriptions of the relevant teaching and learning activities first.

Greenfield's work in collaboration with Childs, videotaping and analyzing instruction sessions between novice weavers and their teachers, is of special interest in this regard (Childs and Greenfield, 1980). They videotaped 14 girls who varied from fairly expert to those who were starting their first weaving project.

Informal Familiarity with Mature Practice Affects Initial Skill Level

Preliminary investigation of weaving activities revealed a marked contrast between novice weavers with different amounts of familiarity with the weaving process before they had tried it themselves. Greenfield found, in informal observation of a group of adult novice backstrap loom weavers in Cambridge, Massachusetts, who had not spent most of the afternoons of their lives in the company of weavers, that beginners were extremely inept. Zinacanteco girls not only observe weaving for years before doing it themselves, but also imitate weaving in play activities (Blanco and Chodorow, 1964; Cancian, 1974).

Not only have they had an opportunity to develop a concept of weaving techniques, they have also learned much about the finished product. In Nabenchauk, the Zinacanteco hamlet where Greenfield and Childs carried out their studies, girls frequently approached them to look closely at their Zinacanteco clothing. The girls' comments about the weaving and embroidery showed attention to details of construction so fine that they had escaped the notice of Greenfield and Childs until then. Thus Zinacanteco girls have an opportunity to develop a representation of the finished weaving products (although at what age this process starts is unknown). In contrast, the beginning adult weavers in Cambridge, lacking a preexisting representation of either method or finished product, had to use a trial-and-error approach to learning how to weave.

Trial-and-Error Learning and Innovation

Novice weavers in Zinacantan displayed a much higher level of initial skill than those in Cambridge. Preexisting knowledge of "the right way" acquired through observation of expert models, plus help from the teacher when they encountered difficulties, allowed them to proceed in

a relatively errorless fashion; that is, no evidence of a trial-and-error approach was observed. Kaye and Giannino's (1978) research led Greenfield to hypothesize that trial-and-error learning may be associated with greater transfer of skill to new tasks than errorless learning. If so, then we have a possible explanation for the absence of transfer of pattern skill to novel patterns among Zinacanteco weavers: the original learning of the woven patterns was based on observational rather than trial-and-error learning. A further hypothesis is that trial-and-error learning is an educational hallmark of a weaving subculture that values innovation, for trial and error might pave the way for the discovery of new patterns and methods. This result would be intrinsic to the experimentation involved in the trial-and-error method.

We do not mean to minimize the role of cultural values in encouraging either innovation or conservation of tradition; such values are crucial. We are merely proposing that instructional strategies conform to these values and are one means by which societal values are actualized at the level of a concrete activity and its transmission from generation to generation.

The hypothesis of a connection between trial-and-error learning and innovation is further supported by two cultures in which weaving is important and in which pattern innovation is not only permitted but very much valued. One of these cultures, studied by Lisa Aronson, is the Ibo town of Akwete in eastern Nigeria. The other is, like Zinacantan, a Maya community, but is located in the highlands of Guatemala and was studied by Maria and James Loucky. Both sets of investigators suggest that girls learn to weave through the process of trial and error. Initially, miniature looms are set up, and the girls are given leftover scraps of material or grass to weave with. The nature of these materials supports the hypothesis that trial-and-error learning is only permitted in situations where it will not bring economic harm to the teacher. Later, when they start weaving real items on real looms, they are basically left alone—that is, there is no teacher hovering, waiting to intervene at the slightest sign of an error. Typically, the only people around are siblings who give advice but generally do not know how to weave themselves. Thus, in both Nigeria and Guatemala, weavers begin their craft by trial-and-error learning and finish by creating original designs.

In conclusion, the evidence available does indicate that cultural values promoting innovation are associated in the domain of weaving with the instructional technique of trial-and-error learning. Cultural values promoting the maintenance of tradition, in contrast, may be actualized in weaving instruction through observational learning.

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The Role of Scaffolding and Task Sequencing as Instructional Techniques

Educators have high regard for what is sometimes called "scaffolding" as an approach to instruction (Wood, Bruner, and Ross, 1976). Here the teacher designs instruction to fit the requirements of each learner, helping with the hard parts of the task, then backing off to let the learner do the parts that are within the range of his or her capabilities. Scaffolding closes the gap between task requirements and the skill level of the learner, thus creating what Hunt (1961) has called "the match." Yet effective instruction must operate in a "zone of proximal development," Vygotsky's (1977) term for the range of problems that learners cannot solve independently but can solve with the help of a teacher. If instruction is to push development forward, it cannot be limited to already acquired skills. Wood, Wood, and Middleton (no date) identify this "region of sensitivity" to instruction as lying in the gap between comprehension and production; the new skill component must be comprehensible although it has not yet been produced. This idea, applied to scaffolding, means that the teacher provides the minimum necessary scaffolding for the learner to produce new skill components that are understood but not yet performed. Wood, Wood, and Middleton have demonstrated experimentally that a scaffolding technique incorporating this pacing principle, which they call contingent instruction, is more effective in teaching 3- and 4-year-old children a difficult construction task than pure demonstration, pure verbal instruction, or alternation of demonstration and verbalization without reference to the learner's current skill level.

Analysis of the videotapes of Zinacanteco weaving shows that teaching and learning activity follow a scaffolding model in some respects. In the earliest stage of learning, the girls spend a bit more than half their time watching the teacher perform the weaving task. As they get more proficient, more and more of their interaction with the teacher is of a cooperative, participatory variety. Teacher intervention changes from taking over the weaving from the learner to participating cooperatively as learners gain more experience. Thus cooperative activity goes from 36 percent to 47 percent to 76 percent of total teacher intervention across levels of previous experience. And the amount of time the learner spends weaving independently goes from 7 percent for first-time weavers to 52 percent if the girl has already made one garment, to 58 percent if she has made two to four items, to 100 percent independent work for the expert. As the amount of cooperative participation and independent weaving goes up, the amount of observation, of course, goes down.

Since the major differences in the amount of teacher control of the weaving process are a function of previous weaving experience, and therefore of skill level, developmentally graded scaffolding seems intrinsic to the instructional process. Scaffolding means that the teacher provides just the amount of help required for the task to be successfully completed by the learner.

But there is another sort of developmental sequencing as well: providing easier tasks earlier in the learning process, so that the learner has a better chance of success even without teacher intervention. Thus items made in early stages of the weaving process are generally small, require few weaving cycles to complete, and require less strength on the part of the young weaver than larger garments assigned to the more experienced weavers.

Task sequencing seems to come into play wherever it is practical to introduce component skills in their order of difficulty. Thus the major processes of turning thread into finished garments are learned in roughly their order of difficulty. For example, Zinacanteco weavers learn to boil thread before learning to weave, but learn to weave before they learn to spin. This ordering is practical because each of these processes constitutes a separate task, with its own set of equipment, materials, and so on. Ordinarily only one of these processes would be carried out on a given day. These characteristics do not hold for the component parts of weaving itself, which are done in rapid succession to one set of materials on the same day. Because of these characteristics, it is important to learn to integrate the steps as well as learn each step in itself. It is therefore not surprising that within the process known as weaving, steps are introduced to the learner in the order that a mature practitioner carries them out, not according to order of difficulty.

Where some parts of a process are more difficult than others, the concept of scaffolding implies greater teacher intervention at the more difficult parts. In this way, task difficulty is always maintained within the ability range of the learner. Childs and Greenfield did find greater teacher intervention on the harder steps and less intervention on the easier ones. For instance, all teachers intervene more on the more difficult first cycle of weaving than on an easier later cycle.

It is interesting that among the tailors a similar two-level system of teaching exists. The major chunks of the process—cutting, sewing, and finishing—are learned from simplest first to most difficult last. This is the reverse of the order in which a mature practitioner carries out the tasks. But within each chunk, steps are taught and practiced in the order in which they will be carried out in mature practice, without regard to their relative difficulty.

It seems likely that there are conflicting pedagogical goals here. Both weavers and tailors demonstrate that they are quite capable of reordering the sequence of segments of mature practice to make them more accessible to novices. If they choose not to do so *within* a given chunk, it may well be because it is less practical and because the function of practice for the novice is to integrate component skills into a smooth sequence of interrelated steps. If the learner needs to learn how to carry out such sequences, then this learning is best served by practicing the correct sequence, even if it means initial difficulties for novice learners and perhaps a greater need for careful scaffolding activity on the part of the teacher. It would be interesting to know whether difficulty level is controlled within a chunk through scaffolding in Liberian tailoring as in Mexican weaving.

Anthropologists have claimed that in informal education the balance of responsibility for the transmission of knowledge is tipped in the direction of the learner because there is little formal teaching. The phenomenon of scaffolding reveals just the opposite. For teachers to follow an implicit rule of doing the minimum required for learners to be successful, they must exercise careful attention and thoughtful effort in judging when to step in and when to refrain from interfering. Maintaining a constant level of difficulty for the learner is clearly a technique that places responsibility on the teacher. Explicit pedagogical theory is not necessary in order for a teaching person to take responsibility for knowledge transmission. In fact, one adult Zinacanteco stated that Zinacanteco girls learn to weave "by themselves." If this woman is typical, the Zinacantecos have very systematic methods of instruction while placing no ideological emphasis on the teaching role.

Another Look at the Role of Language

What about the role-of-language hypothesis? One interesting finding was that extrinsic verbal reinforcement (praise or blame) is essentially never used in this teaching–learning situation, which results in "no-failure" learning. Far more important than immediate extrinsic reinforcement is the broadly shared understanding of Zinacantecos that all normal women weave major items of clothing for their families. Childs and Greenfield's videotapes provide dramatic evidence that extrinsic verbal reinforcement is not necessary to produce learning in this situation.

Another finding has to do with the uses of verbal communication by both teacher and learner. The teachers do what appears to be a good deal

of talking: On the average they produce five to six utterances per minute. The teacher gradually reduces the amount of talking as the girl gets more expert. There is other evidence that the teacher is fitting her instructions to the level of the learner. While there are few questions and explanations in the teacher's talk at any stage of learning, the proportions of commands and of statements, which make up most of the talk, shift as the learner becomes more adept. At the earlier stage about 75 percent of the teacher's utterances are commands, 25 percent statements. These proportions change to about 50–50 as the girl becomes more adept. The girl, on the other hand, does very little talking at any stage of the process, compared to her teacher. Childs and Greenfield compared the proportion of utterances made by the one girl with some schooling to another girl with the same amount of weaving experience, but no schooling. The girl who had some schooling did talk more—the school girl produced 11 percent of the talk between learner and teacher, as opposed to 3 percent by the comparable girl who had not been to school. Whether the effect of going to school is to directly teach verbal communication skills, whether it has the effect of raising the girl's status, or whether it changes the definition of a low-status role, or all three, is an open question.

Greenfield and Childs were able to test two specific hypotheses about the uses of language in informal instruction: these have to do with interaction between verbal and demonstration modes of teaching. The first hypothesis was that instructional redundancy across modes would go down as learners got more skillful. That is, combined visual demonstration and verbal instruction would be used in the early stages, and either demonstration (such as measuring the width of the warp threads) or verbal instruction (for example, "Don't put it in like that") would be sufficient at later stages, when the learner could already be presumed to have both knowledge and practice at weaving. The data strongly support the hypothesis. As the learner becomes more expert, the proportion of teacher-initiated interactions involving both verbal and nonverbal elements declines steadily. Thus while demonstration and verbal intervention both decrease as the learner gains skill, redundancy between the two also decreases.

The second hypothesis was that the weaving teachers, in this relatively informal teaching–learning situation, would be skilled users of language, and that they would adjust the specificity of their verbal output to meet situational demands. For instance, if the teacher is herself sitting within the loom and showing the girl how to weave, she can use gestures and actions to make a vague verbal statement informationally specific (for example, "Do it like this," accompanied by a demonstration). The same

verbal behavior at a distance of 10 feet from the loom would convey no information because no demonstration would be possible. The data show that the specificity of the verbal component of teacher messages in fact goes up as the physical possibility of supplementing with nonverbal information goes down. Thus teachers do indeed adjust the specificity of their linguistic messages in sensitive accord with the requirements imposed by their distance from the learner and her weaving.

SUMMARY AND CONCLUSIONS

From the perspective of the formal–informal theory of crucial differences between educational forms, we have covered a very wide range of variation in this chapter. The three major varieties of education that have been discussed range along a continuum of increasing formality: (1) weaving, where teaching and learning go on in the context of general-purpose family relationships in the course of daily activities in the household; (2) tailors' apprenticeship, where teaching and learning take place in the context of ongoing daily activities but where these activities are full-time specialized craft and business activities; and (3) school, in which learning and teaching are strongly separated from the arenas of mature practice, and teachers are taught how to teach. As far as schooling is concerned, we have limited ourselves to discussing cognitive effects, but have not delved into questions concerning the nature of teaching–learning interactions within the classroom.

We conclude first that there exists a great variety of instructional techniques in informal learning situations. "Teaching by demonstration" is *not* a sufficient characterization of informal teaching techniques in either Zinacantan or Liberia. "Learning by observation and imitation" is *not* sufficient to account for learning activities in either the weaving or tailoring settings. Other techniques such as trial and error, verbalization, and cooperative participation also occur, depending on factors such as culture and learner's skill level. Often techniques are combined to yield scaffolded learning, which is an active, organized enterprise. Teachers present verbal instructions coordinated with demonstration and actual performance, and fit these to the needs of learners. Thus the stereotyped association of verbal instructional strategies with formal education, and nonverbal instructional strategies with informal education, is not appropriate. If language use in teaching has a major role in differential cognitive performances by those who have been to school and those who have not, it may well be a specific one.

Second, we reject the view that there is little pedagogical organization to learning when it takes place in the context of daily activities. Instruction of weavers and tailors is both systematic and adaptive. Both Zinacanteco weaving teachers and Liberian master tailors reorder the clearly separate chunks of their respective craft processes in order of task difficulty. In addition, the Zinacanteco weavers use scaffolded intervention to achieve developmental sequencing within chunks. This results in relatively errorless learning under circumstances where errors would cause considerable economic harm to the teacher's household. The Liberian master tailors allow some trial-and-error learning at the early stages, under conditions where errors would have little economic impact on the teacher. Like the weavers, they intervene in the learning process in carefully regulated fashion as the economic consequences increase.

Third, we conclude that each of the diverse educational forms we investigated can lead to generalization from existing problem-solving skills to problem situations that are related in definable ways. The limited nature of generalization skills is characteristic of all of the educational forms discussed here—including schooling.

Fourth, because of the mutual influence of educational settings on each other within a culture (for which we have cited evidence from other people's work rather than our own), it is necessary to dissociate educational techniques and consequences from the categories of formal and informal education. That is, it appears that informal education may take on qualities of formal education in some cultures, and the converse is probably also true. The implications of this adaptability and mutual influence are that school, apprenticeship, home craft training, and other general terms for educational forms each encompass a wide variety of particular values and instruction and learning techniques.

Research thus far indicates that each combination of techniques is adapted to some purposes and not to others, and that there is no single "best" method. If this is the case, then we should guard against the educational hegemony of particular techniques associated with formal schooling. Future education need not look only to the school for its inspiration. It can also draw upon the rich pedagogical heritage of informal education.