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Transfer of Learning Across Cultural Practices

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Although Baranes, Perry, and Stigler (this issue) address important aspects of the interplay between learning in school and out-of-school settings, I found the more intriguing issues linked to some unanalyzed presuppositions about the character of children's out-of-school mathematics and transfer of learning between settings. In the following commentary, I sketch some interpretive problems that arise when these issues are considered, and I point to the need for embedding the study in a larger conceptual framework.

CHILDREN'S OUT-OF-SCHOOL MATHEMATICS

There has been increasing evidence that, in their out-of-school practices, children construct arithmetical knowledge with properties distinct from school-linked knowledge (Carraher, Carraher, & Schliemann, 1985; Ginsburg, 1977; Resnick, 1987; Saxe, 1988). An assumption guiding the Baranes et al. treatment—that children are structuring a math of time and money in their everyday activities—fits well with this literature on out-of-school knowledge. Baranes et al., however, do not provide an analysis of the children's out-of-school mathematics, and without it, we lack insight into factors that may be important for interpreting the Baranes et al. transfer findings.

Three aspects of children's math linked to time and money are important to the analysis of transfer: (a) the nature of the time and money activities with which children are engaged, (b) the mathematical units that children invent in reasoning and problem solving with time and money, and (c) the procedures children use in producing computations with these units. The character of any of these three aspects of children's out-of-school math may have influenced Baranes et al.'s transfer results in significant but unknown ways.

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Activity Contexts

In their daily lives, children may be engaged with a variety of activities involving time or money. These activities—and the mathematical problems that emerge during participation—may vary both in their mathematical complexity and in the frequency of occurrence. In the case of money, for instance, children may be involved with activities that vary in the complexity of mathematical operations entailed. They may be involved with activities in which they merely identify currency units, in which they compare the relative value of currency units, and in which they perform arithmetical computations with units. Furthermore, for some children, computational activities may occur less frequently than noncomputational activities involving money.

Several studies that colleagues and I have conducted document marked variability in the mathematical complexity of children's mathematical activities, and this complexity is related to the character of children's mathematical knowledge. In prior work with young children from working-class and middle-class homes in the United States, we found that the mathematics emerging in everyday cultural practices shifted over age; we also found that the complexity of the problems was related to children's competence, controlling for both age and social class (Saxe, Guberman, & Gearhart, 1987). In studies with child candy sellers in Brazil, I found that sellers at different ages were engaged with computational problems involving money that varied in mathematical complexity; 5- to 7-year-olds principally were engaged with problems of recognizing bills in interactions with customers and exchanging a particular number of candies for a particular bill denomination; in contrast, older children were increasingly engaged with computational problems (Saxe, 1988, in press-a). Finally, Guberman (1987), in a study of children living in a Brazilian shantytown, showed that although children across a wide age-range often run errands to purchase goods for their households, their computational responsibilities shift over age. Young children are typically given only the exact change so that computational problems did not emerge; they merely produced bill-for-goods exchanges. Older children were given more responsibility to produce computations associated with the purchase of goods. Guberman reported that, when age is controlled, the level of complexity of children's math-linked responsibilities predicts children's arithmetical knowledge.

These findings about relationships between the mathematical complexity of children's activities and their mathematical competence bear directly on Baranes et al.'s results. On their time and money tasks, Baranes et al. report that children manifest transfer when problem contexts and problem numbers are linked to money but not time. It may very well be that the asymmetry of transfer is linked to children's activity participation: In the populations sampled, children may have been more frequently engaged with problems linked with money as opposed to time, and the nature of the money problems as contrasted with the time problems may have more typically been arithmetical ones.

Numerical Units

Baranes et al. make assumptions about the way children cognize units in the time and money domains that may not be warranted (as Baranes et al. point out in their discussion). How children understand units of time and money is important to understanding children's time-linked and money-linked math. Children may not only use units different from ours, but some children, particularly young ones, may not even use denominational structures for time and money.

From prior research, we know that when kindergartners are presented with tasks requiring them to consider denominational units, they often respond as if they conceptualized all tokens as having the same value (Kamii, 1986; Saxe, Becker, Sadeghpour, & Sicilian, 1989; Strauss, 1954). With age, children shift to respecting the denominational structure of the representational systems, although the character of this shift is not well understood. Such shifts most likely carry with them new problems with respect to units. Children begin to structure ordinal and many-to-one correspondence relations, not only between units and larger values (e.g., 10 pennies = 1 dime; 60 minutes = 1 hour), but also between values that differ from unity (e.g., 2 dimes and 1 nickel = 1 quarter; 2 half-hours = 1 hour).

Baranes et al.'s selection of time and money units is guided by adult norms. It is quite plausible that in transfer tasks such as the ones used in the Baranes et al. study, children's prior construction of and fluency with particular units that differ from adult norms may affect children's transfer. As Baranes et al. themselves point out, by selecting time and money numbers without knowledge of children's time and money units, they risk not detecting transfer when it might very well occur.

Procedures for Manipulating Units

Understanding the character of children's computational procedures is central to understanding children's domain-linked mathematics. We know that the computational procedures children use to solve arithmetical problems may assume very different forms. The procedures of one child who determines the value of six quarters by laboriously counting imaginary pennies are very different from those of another child who uses an abbreviated procedure of grouping the quarters into a set of four and a set of two. It is plausible that such differences would have very different implications for the child's transfer of currency-linked knowledge to solving school math problems. In the first case, the child may gain little by making use of the currency-linked strategy; in the second, the child may gain considerable economy of effort. Again, to understand processes mediating transfer, knowledge of children's ways of organizing domain-specific problems into specialized procedures may be an important interpretive base for the analyst.

TRANSFER BETWEEN IN-SCHOOL AND OUT-OF-SCHOOL CONTEXTS

The second construct in need of further analysis in the Baranes et al. study is learning transfer itself. Transfer is typically conceptualized as a process of generalizing prior learning or aligning prior cognitive forms to new problems. In the methods associated with these conceptualizations of transfer, individuals are typically presented with some short-term learning exercises and then transfer is assessed in terms of pass/fail performances on transfer tasks. Baranes et al. cast their study in terms of these traditional approaches (at least at times they use the language of these approaches), yet they focus not on knowledge linked to short-term training and assessment in the lab, but rather on knowledge children construct in everyday practices, practices involving using currency, telling time, and doing school-linked mathematics. In so doing, the traditional interpretive frameworks and language of transfer may not be well suited to analyzing the processes at work in mediating transfer in the Baranes et al. study.

Unlike the laboratory setting, everyday situations—including learning math both in and out of school—engage children in problems on a repeated basis. Furthermore, unlike the close correspondence between problem structures that characterize many problems presented in standard paradigms (e.g., the addition of three quarters versus 25 + 25 + 25 = ?), the different problems emergent in everyday practices may be less exact, requiring a tailoring and specialization of knowledge generated in one context to address a problem in another. Finally, we often find that there are social supports in which individuals may provide for using knowledge structured in one practice for another, as when a teacher provides explicit instruction in arithmetic using currency (see Laboratory of Comparative Human Cognition, 1983). Because of these differences, what we take as a phenomenon of transfer in everyday life may be very different in character from transfer in the laboratory.

Transfer in the context of everyday problem-solving may occur as a protracted process in which individuals appropriate knowledge forms from one context and specialize them in another (Saxe, in press-b). Thus, children may begin to make use of a currency-linked strategy of regrouping quarters to solve similar (but not identical) school computational problems; problems in application of the currency strategy may, in turn, lead the child to construct a more specialized strategic form, such as working through a regrouping procedure applied to noncurrency units. Furthermore, the process of appropriation and specialization may be interwoven with social interactional processes that emerge in practices. For instance, in second- and third-grade classrooms, children are commonly presented with worksheets including currency computations and may be given instruction on linking their currency-based computations with more formal mathematical problem solving.

Baranes et al. use methods that reveal some evidence of transfer. These methods, however, are blind to the process of appropriation and progressive specialization of knowledge across contexts. Indeed, the study of transfer of this sort would require a coordinated treatment of children's out-of-school mathematics focusing on (a) everyday practices and developing forms of computational units and procedures children are structuring and (b), in a parallel analysis, school-linked mathematical activities. Such an analytic tack would set the stage for analyzing the kinds of mathematical forms children may be appropriating and specializing to accomplish the problems linked to school. Clearly, this is an ambitious task, one outside the scope of Baranes et al.'s concerns, but perhaps central to understanding transfer between in-school and out-of-school learning.

In summary, Baranes et al. isolate some relevant and interesting factors in the structure of word problems—problem numbers and problem contexts—that mediate children's appropriation and use of knowledge forms linked to a math of time and money. The study, however, needs to be set in a larger framework. In moving toward the study of learning transfer outside the laboratory, we need to produce new methods that more closely reflect children's construction of knowledge forms in everyday practices and the way children may appropriate and specialize these practice-linked forms to solve problems that emerge in other practices.

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REFERENCES

Carraher, T. N., Carraher, D. W. & Schliemann, A. D. (1985). Mathematics in the street and in schools. *British Journal of Developmental Psychology, 3*, 21–29.

Ginsburg, H. P. (1977). *Children's arithmetic: The learning process*. New York: Van Nostrand.

Guberman, S. R. (1987, April). *Arithmetical problem solving in commercial transactions of*

Brazilian children. Paper presented at the meeting of the Society for Research in Child Development, Baltimore.

Kamii, C. (1986). Place value: An explanation of its difficulty and educational implications for the primary grades. *Journal of Research in Childhood Education, 1*(2), 75–86.

Laboratory of Comparative Human Cognition. (1983). Culture and cognitive development. In W. Kessen (Ed.), *Handbook of child development* (Vol. 1, pp. 295–356). New York: Wiley.

Resnick, L. B. (1987). Learning in school and out. *Educational Researcher, 16*(9), 13–20.

Saxe, G. B. (1988). Candy selling and math learning. *Educational Researcher, 17*(6), 14–21.

Saxe, G. B. (in press-a). *Culture and cognitive development: Studies in mathematical understanding*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Saxe, G. B. (in press-b). The interplay between children's learning in school and out-of-school contexts. In M. Gardner, J. Greeno, F. Reis, & A. Schoenfeld (Eds.), *Toward a scientific practice of science education*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Saxe, G. B., Becker, J., Sadeghpour, M., & Sicilian, S. (1989). Developmental differences in children's understanding of number word conventions. *Journal for Research in Mathematics Education, 20,* 468–488.

Saxe, G. B., Guberman, S. R., & Gearhart, M. (1987). Social processes in early number development. *Monographs of the Society for Research in Child Development, 52*(2, Serial No. 216).

Strauss, A. L. (1954). The development of conceptions of rules in children. *Child Development, 25*, 193–208.