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Employing Siegler's Overlapping Waves Theory to Gauge Learning in a Balanced Reading Instruction Framework

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ABSTRACT

Balanced reading instruction proposes an alternative to phonics only or whole language only programs; offers an efficient mixture of instructional approaches; and reconciles an array of learning styles. Although this balanced approach can not be interpreted monolithically, due to the various ways that whole language and phonics can be taught and combined, learning to read fluently functions as its intrinsic goal. Such a goal, moreover, implies that learning evolves through strategies. Central to this article is the assertion that Siegler's overlapping waves theory and microgenetic analysis can be employed to gauge children's learning, or acquisition of strategies, within a balanced reading instruction framework. Implications regarding how classroom instructional procedures employing Sielger's work exert their effects on balanced instruction are discussed.

Introduction

Over the last several decades, increasing numbers of educators have gradually become disenchanted with single approaches to teaching reading, especially with those approaches reflecting extreme versions of phonics or whole language that claim to be essentially superior to all others. According to Bond and Dykstra (1967), the First-Grade Studies project concluded that various materials and methods enable children to learn how to read and that the most effective path to teaching reading entailed a combination of approaches—not a specific, single approach per se.

This balanced approach, however, can not be interpreted monolithically because of the various ways that whole language and phonics can be taught and combined. For example, Kelly (1997) asserts that a combination of phonics and whole language approaches typically define balanced reading instruction because of children's need to acquire knowledge in both phonemic awareness and in cueing strategies. Carbo (1996), on the other hand, stresses the role of various learning styles. More specifically, she states that phonics instruction benefits students with analytic and auditory learning styles, while whole language instruction benefits students with learning styles of a visual, tactile, and global nature. Raven (1997) maintains that different approaches are needed for specific stages of reading acquisition (e.g., selective cueing, grapho-phonemic, and automatic). From Honig's (1996) point of view, balanced instruction entails meshing language, literature, and comprehension with systematic skills instruction explicitly taught. Weaver (1998), however, suggests that we focus not only on reading but also on literacy; this focus is broadly defined as encompassing the integration of language and literacy across both language modes and disciplines, in addition to focusing on skills and strategies associated with reading, writing, and learning in context through the use of texts that are whole and meaningful. Finally, McIntrye and Pressley (1996) assert that cultural and psycholinguistic dimensions undergird balanced instruction's theoretical base.

The aforementioned researchers' (Carbo, 1996; Honig, 1996; Kelly (1997); McIntrye & Pressley, 1996; Raven, 1997; Weaver, 1998) interpretations of balanced reading instruction provide persuasive evidence that balanced instruction proposes an alternative to phonics only or whole language only programs; offers an efficient mixture of instructional approaches; and reconciles an array of learning styles. Despite balanced instruction's various interpretations, learning to read fluently functions as its intrinsic goal. Such a goal, moreover, implies that the learning that occurs during children's attempts to read fluently does not differ from the learning that occurs during their attempts to perform other tasks (e.g., solving math problems, applying the steps of the scientific method) because learning requires the use of strategies. Consequently, children, out of necessity, discover, acquire, utilize, and modify a variety of strategies while endeavoring to learn how to read successfully. For example, during the phonics component of balanced instruction, children must incorporate certain strategies to enhance their decoding performance (e.g., rhyming, blending, segmenting, minimal contrast, combining strategies [e.g., phonics, structural analysis, and context clues]). During the whole language component of balance instruction, children must also incorporate certain strategies to enhance their comprehension (e.g., activating prior knowledge, using graphic organizers, incorporating newspapers and other sources, studying text structure or text organization [e.g., description, sequence, comparison and contrast, problem solution, cause and effect]).

Purpose of the Article

Central to this article is the assertion that, given the pivotal role of learning (and its concomitant dependence on strategies), Siegler's overlapping waves theory and microgenetic analysis has much to offer practitioners' of balanced reading instruction (Siegler, 2000). Accordingly, the role and nature of learning within Siegler's overlapping waves theory and his use of microgenetic analysis will be discussed. Then the implications of learning derived from Siegler's work for balanced reading instruction will be examined.

Siegler's Overlapping Waves Theory

Formerly, children's learning was developmental psychology's central topic; however, with the ascension of Piaget's theory associated with developmental psychology and with the cognitive revolution that occurred in adult experimental psychology, the focus shifted from learning to thinking (Slavin, 2005). Moreover, this new emphasis on studying children's thinking reflected not only a shift in interest but also an assumption that development and learning embodied essentially different processes. Consequently, studies of children's learning declined drastically. One central fact, however, cannot be overlooked: performance is critical in adults' lives, relative to learning; in contrast, learning is critical in children's lives, relative to performance. Any theory of development, therefore, that diminishes the role of learning in children's lives is a restricted theory of development (Siegler, 2000).

The significance of children's learning for a coherent grasp of development has prompted an increasing number of investigators to undertake the challenges involved in studying it forthright. These investigators who approach this task, furthermore, represent a variety of theoretical backgrounds: neo-Piagetian (Fischer & Bidell, 1998), cultural contextualist (Granott, 1993), dynamic systems (van Geert, 1998), and information processing (Munakata, 1998). It should be noted that although none of these aforementioned approaches has focused specifically on children's learning, each, nonetheless, is allocating more attention to it.

One theory, however, does focus fundamentally on how children learn: Siegler's (2000) overlapping waves theory or waves metaphor of cognitive development. He specifically created this model of cognitive development to better embrace the idea of cognitive variability because he contends that stage theorists' staircase metaphor of cognitive development (e.g., Piaget) neglected the extensive occurrence of variability during and between stages of development (Slavin, 2005). Hence, Siegler is interested in the number of strategies that a child might use at any age rather than in which specific strategy a child might use most during which stage. In viewing variability from an evolutionary perspective along Darwinian principles, Siegler does not advocate the abandonment of research compiled from the past; rather, he seeks to better illustrate how children develop.

Siegler's (2000) theory is predicated on three assumptions: (1) when solving a problem, children typically employ several strategies and ways of thinking, rather than merely one; (2) the various strategies and ways of thinking coexist over long intervals, not only during short transition periods; (3) experience manifests changes in children's relative reliance on current strategies and ways of thinking and initiates more advanced approaches.

According to Siegler (1996), the cognitive variability asserted by his overlapping waves theory seems to exist at all levels of analysis. First, it occurs within and across individuals. Studies focusing on tasks such as arithmetic, serial recall, and spelling revealed that children utilized a minimum of three strategies. Second, the variability also appears within an individual unraveling the same problem encompassing two occasions at close intervals. For example, one third of the children who were given an identical addition problem at two different times in one week applied different strategies (Siegler & McGilly, 1989). Third, cognitive variability even occurs within single trials. During the same trial, children may convey a different strategy in speech and gesture, respectively (Goldin-Meadow, Alibali, & Church, 1993).

Five Dimensions of Learning

Overlapping waves theory distinguishes among five dimensions of learning: acquiring appealing strategies, mapping strategies onto new problems, strengthening strategies for consistent usage within given problem sets where they have begun to be applied, refining choices among optional strategies or alternative forms of a single strategy, and executing appealing strategies increasingly efficiently (Chen & Siegler, 2000).

Acquisition of appealing strategies. Acquiring new strategies constitutes a mandatory first step in strategy development because each strategy in a child's repertoire must be initiated at some point. Such acquisitions usually occur by relying analogically on better-understood problems, by generating mental models of the situation and speculating about them, by making observations throughout the period of problem solving, and by receiving direct verbal instruction.

Mapping strategies onto new problems. Attempting to map strategies onto new problems is a formidable task because it entails generalizing them from one context to other contexts in which they are applicable. Generalization, in turn, requires that the problem solver distinguish between relevant and irrelevant facets of the context in which the new strategies were initially acquired. Unfortunately, if strategies are mapped onto novel problems predicated on similarities between cursory features of the original and new contexts, problem solvers might employ the strategies when not applicable, might fail to use them when applicable, or both. On the other hand, grasping the principles of strategy applicability results in successful mapping of the novel approach.

Strengthening strategies for consistent usage. Strengthening recently acquired strategies, both in their original settings and in the settings to which they are mapped, constitutes a third dimension of learning. Given that children think in a variety of ways over extended time and that some of their ways of thinking are more enhanced than others, the caliber of their thinking can advance assuming they rely more on novel, comparatively advanced approaches and decrease their dependency on less advanced ones. Regrettably, both children and adults often do not rely on newly acquired strategies, even when they are significantly more efficient than older alternatives (Siegler, 1995). The new approaches' limited use is often due to problems in retrieving the novel strategies and problems in suppressing older strategies.

Refining choices. The refinement of choices among optional strategies or alternative forms of a single strategy is the fourth dimension of learning. A child can increasingly concentrate on each strategy from his/her repertoire of strategies on problems deemed most useful for that strategy not only when the set of strategies remains constant but also when each strategy's overall frequency remains constant. The degree of preschoolers' and older children's adaptiveness frequently increases as their experience in the domain increases (Lemaire & Siegler, 1995).

Executing appealing strategies. Enhancing efficient execution of novel strategies is the fifth dimension of learning. Even if no changes occur in the acquired repertoire of strategies, in the number of problems used for mapping strategies onto, in the incidence of any strategy regarding either original or transfer problems, and in the accuracy of strategy choices, children's precision and quickness can advance considerably with increased practice in the execution of each approach.

Data conforming to Siegler's overlapping waves model have reflected commonalities in children's learning across varied tasks: arithmetic, reading, serial recall, spelling, and scientific experimentation. In each domain, children applied multiple strategies at all ages with cognitive variability occurring within and across individuals; moreover, in all of these areas, children's shift toward more refined approaches increased with age and experience. These same traits also characterize adults' thinking and learning as demonstrated in such varied domains as sentence-picture verification and spatial reasoning (Chen & Siegler, 2000). These findings regarding both children's and adults' learning have also formed the foundation for other models of children's learning, notably computer simulation models (Shrager & Siegler, 1998) and dynamic systems theories (Smith, Thelen, Titzer, & McLin, 1999; van Geert, 1998), both of which share many assumptions regarding how learning evolves with the overlapping waves model.

The three assumptions underlying overlapping waves theory and its five dimensions of learning, accordingly, reflect the complexities entailed in children's attempts to learn how to read fluently during decoding and/or comprehension phases. Siegler's focus on the extensive occurrence of strategy variability during and between stages of development ushers in a new paradigm, or perspective, that is more accurate and efficient than the staircase metaphor of cognitive development at explaining children's learning during reading, or during any other cognitive task. Hence, we should expect enormous inter- and intra-individual variability in terms of decoding and comprehension strategy development during reading performance (Siegler, 2000).

Microgenetic Analysis

Together, these aforementioned theories converge on a new set of priorities for analyzing children's learning. Instead of attempting to pinpoint a specific age associated with a child's development of a given capability, we would analyze the variability of existing strategies as well as the emergence of novel ones. Another priority would require us to examine the effects of age and experience on children's abilities to readily adjust how they approach the demands of problems and situations. A third priority would require us to analyze the emergence of discoveries as well as their generalization once they have emerged. Fortunately, microgenetic analysis, a new methodological approach for examining children's learning, can address each of these issues, while supplying much of the underpinning for Siegler's overlapping waves model (Siegler, 2000).

Predominant research methods intrinsically affect, and are affected by, pivotal questions associated with predominant theories. For example, theories focusing on questions such as "At what point do children grasp a specific math concept?" or "How are the development of knowledge states that enable children to grasp a specific math concept sequenced?" harmonize well with standard cross-sectional and longitudinal methods that typically survey children's thinking at various ages. In contrast, these two methods are inadequate if "What processes do children employ to learn a specific math concept?" or "What procedures do children utilize to acquire new knowledge about a specific math concept?" are the central theoretical questions because observations of emerging intellectual competence, employing the two aforementioned methods, are spaced too far apart to provide sufficiently detailed feedback about the learning process (Siegler, 2000).

This, on the other hand, is precisely where microgenetic methods are especially suitable for resolving issues pertaining to the learning process. These methods, according to Siegler and Crowley (1991), have three primary features: First, observations encompass the duration of swiftly fluctuating competence from the onset of rapid change to the stable use of target modes of thinking. Second, during this period, the number of observations is extensive, relative to the rate of change. Third, observations are qualitatively and quantitatively analyzed intensively to infer the cognitive processes responsible for the ongoing changes.

The second feature above is especially significant because if children's learning occurred in a purely straightforward fashion, the need for dense sampling of fluctuating changes would be obviated. Instead, cognitive changes entail both regressions and progressions, peculiar transitional states that are ephemeral but pivotal for changes to occur, and other surprising characteristics. In essence, ascertaining how children learn necessitates that we closely observe them during the learning process.

Recently, microgenetic methods have been employed to analyze an increasing scope of age groups, content domains, and issues: infants' ability to learn both reaching and locomotor skills (Adolph, 1997), preschoolers' ability to learn both attentional strategies and number conservation (Siegler, 1995), elementary schoolers' ability to learn memory strategies, mathematical principles, analogical reasoning (Alibali, 1999; Chen & Klahr, 1999), and adolescents' and adults' ability to learn scientific experimentation skills (Schauble, 1996).

Four Consistent Findings

In spite of the investigators' diversified theoretical predispositions, tasks' varying content domains, and children's varying age span studies, the picture that emerges from microgenetic studies of learning is conspicuously similar. Four consistent findings, in fact, account for much of the microgenetic studies' strikingly similar discoveries.

Change per se tends to be gradual. In a preponderance of studies of children's learning, researchers have consistently discovered that change is gradual. Even when improved ways of thinking about a task surface, learners continue to employ older, less efficient ways of thinking about it for a long time after (Kuhn, 1995; Schauble, 1996). Gradual changes in learning are especially likely to occur when a new approach is not significantly advantageous compared to current approaches because early approaches frequently tend to be moderately efficient. However, even when approaches arise that are potentially very advantageous, they may not surface because they cannot be effectively executed (Bjorklund, Miller, Coyle, & Slawinski, 1997). Sometimes, when a novel strategy is significantly more efficient than any previous way of thinking, it occasionally dominates quickly; change, however, generally tends to be gradual (Alibali, 1999).

Discoveries materialize out of both success and failure. A second consistent finding from microgenetic analysis of children's learning is that children discover new strategies to solve tasks when they have successfully solved a task as well as when they have failed to solve a task (Karmiloff-Smith, 1992; Miller & Aloise-Young, 1996).

Initial variability is correlated with later learning. A third consistent characteristic of microgenetic studies is that children's initial variability of strategy use is positively correlated with their ensuing rate of learning. Many studies suggest that children's abilities to develop desirable problem solving strategies that obviate inefficient older ones are contingent upon the density of their initial variability of thinking (Perry & Lewis, 1999; Siegler, 1995). Several specific forms of initial variability of strategy use that positively correlate with subsequent rate of learning have been identified: total number of strategies applied to a group of problems, rate of strategy shifting within one trial, rate of self-correcting and deleting of verbal descriptions of strategies, and rate of using speech and gestures, respectively, when expressing strategies during one trial. Coyle & Bjorklund (1997) remind us, however, that all forms of variability in the use of strategies are not necessarily positively correlated with learning. For example, they found that inter-trial changes in strategy use correlated negatively with percent correct recall.

Conceptual understanding guides discoveries. A fourth characteristic of children's learning is that the degree to which a domain is conceptually understood constrains the discovery of new strategies (Coyle & Borklund, 1997; Gelman & Galistel, 1978; Schauble, 1996). Although children's novel strategies do not always successfully solve the problems that evoked them, they frequently function as reasonable attempts, nonetheless. It should be noted that children obviously generate conceptually flawed strategies at times and that two basic reasons account for this: children only partially understand the goals that legitimate domain strategies must satisfy or the situation requires them to produce an answer even though they are not cognizant of any plausible strategy that would work.

As initially stated, the perception that learning and development reflected essentially different processes was largely responsible for shifting the focus away from examining children's learning. Recent research on children's learning, however, provides a strong rationale for rethinking this conclusion. According to Kuhn (1995), when contrasting development to learning, research in the 1960s and 1970s conceptualized the latter simplistically and nonrepresentationally. Learning viewed from this perspective bears little relevance today. Modern research has demonstrated that learning processes also share certain qualities once thought to be the exclusive domain of development, i.e, learning processes are as complex, organized, structured, and internally dynamic as development per se. If time appears to have blurred the distinction between development and learning, the reduction of development to "nothing but" learning is not the reason; rather, it is because we now realize that learning and development are fundamentally similar in many respects.

Hence, microgenetic analysis, which supplies much of the underpinning for Siegler's overlapping waves theory, is a relatively new, significantly effective, and dynamic method for analyzing, assessing, and gauging cognitive change or learning. This technique, consequently, greatly facilitates attempts by practitioners of balanced instruction to study quantitative and qualitative changes in the evolution, modification, adaptation, and acquisition of children's strategies while engaging in decoding and/or comprehension during reading encounters.

Concluding Remarks

Implications of Siegler's Work for Balanced Reading Instruction

Learning entails both the ability to comprehend or understand a principle, concept, or task at hand and the ability to remember essential information for future retrieval purposes. In addition, the successful learning of anything changes an individual to a varying degree. For example, successful learning may improve, to a greater or lesser degree, one's ability to efficiently combine several phonics strategies to decode words or to more competently identify various types of text structure or text organization (Slavin, 2005). Concentrating on children's learning, consequently, will enable us to understand development more comprehensively and to provide us simultaneously with beneficial educational applications. The fact that numerous children frequently fail to learn well in school is certainly nothing new. Meticulous developmental analyses depicting specifically how children learn and/or fail to learn to read, write, and solve mathematics problems may permit us to better understand the nature of learning difficulties and to potentially enrich current programs for remedying them. In essence, these analyses of learning should especially facilitate our ability to pinpoint how classroom instructional procedures exert their effects, enabling us in the future to design more efficacious instructional approaches for improving children's decoding at the automaticity level, enhancing their overall comprehension performance, enabling them to write more articulately, and modeling comprehension monitoring techniques for their application. However, for this to occur, these analyses must successfully specify what strategies children employ when responding to instruction. Frequently, various correct and incorrect strategies may be utilized for solving a class of problems. Each set of strategies, moreover, may be variously applied to a range of problems, differ in their success rate of execution, and vary in the conceptual underpinnings essential for grasping their functioning. Fortunately, success relative to comprehending how instructional procedures exert their effects has already begun to materialize. Geary (1994), for example, identified several dimensions that contribute to mathematics disability: restricted previous exposure to numbers, insufficient working memory space for numerical information, and inadequate conceptual grasp of operations and counting associated with arithmetic.

These examples clearly illustrate a pivotal point: the renaissance of children's learning will not only initiate a more stimulating field of cognitive development but also aid children in the learning process.

References

Adolph, K.E. (1997). Learning in the development of infant locomotion. *Monographs of the Society for Research in Child Development*, *62*(3), 251.

Alibali, M.W. (1999). How children change their minds: Strategy change can be gradual or abrupt. *Developmental Psychology*, *35*, 127-145.

Bjorklund, D.F., Miller, P.H., Coyle, T.R., & Slawinski, J.L. (1997). Instructing children to use memory strategies: Evidence of utilization deficiencies in memory studies. *Developmental Review*, *17*, 411-441.

Bond, G.R., & Dykstra, R. (1967). The cooperative research program in first-grade reading instruction. Reprinted in *Reading Research Quarterly, 32*(4), 348-427.

Carbo, M. (1996). Whole language or phonics? Use both! *The Education Digest*, *61*(6), 60-63.

Chen, Z., & Klahr, D. (1999). All other things being equal: Children's acquisition of the Control of Variables Strategy. *Child Development*, *70*, 1098-1120.

Chen, Z., & Siegler, R.S. (2000). Across the great divide: Bridging the gap between understanding of toddlers' and older children's thinking. *Monographs of the Society for Research in Child Development*, *65*(2), 1-105.

Coyle, T.R., & Bjorklund, D.F. (1997). Age differences in, and consequences of, multiple- and variable-strategy use on a multitrial sort-recall task. *Developmental Psychology*, *33,* 372-380.

Fischer, K.W., & Biddel, T.R. (1998). Dynamic development of psychological structures in action and thought. In R.M. Lerner (Ed.), W. Damon (Series Ed.), *Handbook of child psychology: Vol. 1. Theoretical models of human development* (5th ed., pp. 467-562). New York: Wiley.

Freppon, P. A., & Dahl, K. L. (1998). Balanced instruction: Insights and considerations (Theory and research into practice) *Reading Research Quarterly*, *33* (2) 240-51.

Geary, D.C. (1994). *Children's mathematical development: Research and practical applications*. Washington, DC: American Psychological Association.

Gelman, R., & Gallistel, C.R. (1978). *The child's understanding of number*. Cambridge, MA: Harvard University Press.

Golding-Meadow, S., Alibali, M.W., & Church, R.B. (1993). Transitions in concept acquisition: Using the hand to read the mind. *Psychological Review*, *100*, 279-297.

Granott, N. (1993). Patterns of interaction in the construction of knowledge: Separate minds, joint efforts, and weird creatures. In R. Wozniak & K. W. Fischer (Eds.), *Development in context: Acting and thinking in specific environments* (pp. 183-207). Hillsdale, NJ: Erlbaum.

Honig, B. (1996). *Teaching our children to read: The role of skills in a comprehensive reading program.* Thousand Oaks, CA: Corwin Press, Incorporated.

Karmiloff-Smith, A. (1992). *Beyond modularity: A developmental perspective on cognitive science.* Cambridge, MA: MIT.

Kelly, H. (1997) How children learn to derive meaning from text. (ERIC Document Reproduction Service No. ED416459).

Kuhn, D. (1995). Microgenetic study of change: What has it told us? *Psychological Science*, *6*, 133-139.

Lemaire, & Siegler (1995). Four aspects of strategic change: Contributions to children's learning of multiplication. *Journal of Experimental Psychology: General, 124*, 83-97.

McIntyre, L.D., & Pressley, M. (Eds.) (1996). *Balanced instruction: Strategies and skills in whole language*. Norwood MA: Christopher Gordon.

Miller, P., & Aloise-Young, P. (1996). Preschoolers' strategic behaviors and performance on a same-different task. *Journal of Experimental Psychology, 60,* 284-303.

Munakata, Y. (1998). Infant perseveration and implications for object permanence theories: A PDP model of the AB task. *Developmental Science, 1*, 161-184.

Perry, M., & Lewis, J.L. (1999). Verbal imprecision as an index of knowledge in transition. *Developmental Psychology, 25*, 749-759.

Raven, J. N. (1997). *Phonics and whole language: Friends or foes?* (ERIC Document Reproduction Service No. ED413583).

Schauble, L. (1996). The development of scientific reasoning in knowledge-rich contexts. *Developmental Psychology, 32,* 102-119.

Shrager, & Siegler (1998). SCADS: A model of children's strategy choices and strategy discoveries. *Psychological Science, 9*, 405-410.

Siegler, R.S. (1995). How does change occur: A microgenetic study of number conservation. *Cognitive Psychology, 28*, 225-273.

Siegler, R.S. (1996). *Emerging minds: The process of change in children's thinking*. New York: Oxford University Press.

Seigler, R.S. (2000). The rebirth of children's learning. *Child Development, 71*, 26-35.

Siegler, R.S., & Crowley, K. (1991). The microgenetic method: A direct means for studying cognitive development. *American Psychologist, 46*, 606-620.

Siegler, R.S., & McGuilly, K. (1989). Strategy choices in children's time-telling. In I. Levin & D. Zakay (Eds.), *Time and human cognition: A life span perspective* (pp. 185-218). The Netherlands: Elsevier Science Publishers.

Slavin, E.S. (2005). *Educational psychology: Theory and practice (8th ed.). Boston, MA:* Allyn & Bacon.

Smith, L.B., Thelen, E., Titzer, R., & McLin, D. (1999). Knowing in the context of acting: The task dynamics of the A-Not-B error. *Psychological Review, 106,* 235-260.

VanGeert, P. (1998). A dynamic systems model of basic developmental mechanisms: Piaget, Vygotsky, and beyond. *Psychological Review, 105*, 634-677.

Weaver, C. (1998). *Toward a balanced approach to reading in reconsidering a balanced approach to reading.* National Council of Teachers of English, Urbana, IL. (ERIC Document Reproduction Service No. ED418388).