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ABSTRACT

A study reviewed recent research on issues central to adult learning, learning disabilities, and study skills in seven important areas--reading and listening, writing, arithmetic, memory, metacognition, representational competence, and perceived competence. The review focused on recent findings that had direct implications for the assessment and remediation of study skill deficits in adolescents and adults. Findings indicated that understanding of important psychological processes underlying the ability to learn improved considerably over the past decade. The broad picture emerging from many studies showed the potential for new assessment and remediation procedures aimed at improving study skills in adolescents and adults. This approach served as the theoretical underpinning for the development of an assessment battery that combined new, standardized procedures with well-established, normed tests and a corresponding battery of instructional methodologies for the remediation of specific study skills. In contrast to the traditional deficit model of cognitive abilities that focused on specific information processing deficits, the present approach was multifaceted and included additional components that assessed both the cognitive and affective strengths and weaknesses of the student. The new approach was based on an initial dynamic assessment of processes and on a follow-up application of instructional-based assessment in a mediated learning environment. (Contains 528 references.) (YLB)

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Adult Literacy and Study Skills: Issues in Assessment and Instruction

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Adult Studies Skills Clinic
Ontario Institute for Studies in Education

NCAL Technical Report TR96-13

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Adult Literacy and Study Skills: Issues in Assessment and Instruction

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Abstract

Literacy enables individuals to partake equitably in the employment, social, and cultural activities which constitute their social context. Literacy skills are centered around the effective use of language, especially printed text, and competence in representing and processing quantitative aspects of experience. Since knowledge about language as well as about arithmetic is usually—and largely—acquired though formal schooling, it is not surprising that study skill deficits are commonly reported by participants in literacy programs. This report reviews recent research on issues that are central to adult learning, learning disabilities, and study skills in seven important areas—reading and listening, writing, arithmetic, memory, metacognition, representational competence and perceived competence. The review is selective and focuses on recent findings that have direct implications for the assessment and instruction of study-skill deficits in adolescents and adults.

Introduction

Literacy may be viewed as a type of prerequisite; it enables individuals to partake equitably in the employment, social, and cultural activities that constitute their social context. While different societies may posit different mixes of literacy skills, it is commonly recognized that, in the first and second worlds, these skills are centered around the effective use of language, especially printed text and competence in representing and processing quantitative aspects of experience. Since knowledge about language as well as about arithmetic is usually (and largely) acquired through formal schooling, it is not surprising that study-skill deficits are commonly reported by participants in literacy programs. These individuals, who may come from varied backgrounds (e.g., from shelters for the homeless to business-sponsored courses for the retraining of executives), share a need to improve their study skills prior to (and in order to) enhance the outcome of their literacy training.

There are tacit and overt similarities between literacy and study skills. Functional literacy is widely viewed as the ability to use text in accordance with societal norms (Stedman & Kaestle, 1987). In turn, reading and writing (i.e., the ability to use text in both the receptive and expressive modes) are study skills that are clearly subordinate to a general ability to acquire knowledge. The level of functional literacy, defined by the requirements pertaining to the acquisition and use of knowledge in the course of daily life, varies greatly across cultures as well as within a particular culture in different historical times. Thus, in the United States, functional literacy during the industrial era may have meant, for the most part, the ability to read, understand, and respond to printed advertisements, bills, and job applications. In contrast, in the emergent informational era, functional literacy may mean the ability to read, understand, and respond to dynamic displays of information presented on television and computer screens regarding electronic shopping and banking, and also to quickly master new versions of bulky manuals of application software, in addition to traditional printed text. Contrary to beliefs propagated by media experts who extol the virtues of a textless world resulting from the upcoming multimedia revolution, the quantity of text seems to increase, rather than decrease, with time. The informational era, as its name implies, places much higher demands on the individual in terms of the scope, type, and amounts of information that have to be understood and responded to (sometimes within narrow time limits) in the course of daily life. This is especially true with respect to employment, where the repertoire of job descriptions in a technology-driven economy evolve rapidly, and keeping a job may require several cycles of retraining during one's working life. Clearly, good study skills are a prerequisite for such a process of updating one's job-related skills through continuous knowledge renewal.

There are many similarities between problems reported by adults in literacy programs and by adults with learning disabilities. Notably, both groups are deficient high-level study skills (e.g., reading comprehension, writing, arithmetic, memory strategies, etc.). It is likely that the impact of a learning disability (sometimes diagnosed early but often unlabeled and latent) on the individual's path of development will result in a deficient educational experience with a concomitant problem in literacy in later years. The proportion of learning-disabled individuals among adults participating in literacy programs in the United States has not been documented, but it is reasonable to assume that it is higher—possibly much higher—than the proportion of learning-disabled adults in the general population.

From a clinical perspective, these similarities between the "presenting problem" of an adult LD and an adult with a low level of literacy skills during the intake clinical interview are sometimes striking. Indeed, the clinician will often be at a loss to distinguish between these two conditions, even following assessments that often document specific, similar deficits in the two cases. For example, Bristow and Leslie (1988) found that single-word decoding, comprehension, rate, and miscue quality were valid indicators of difficulty for illiterate adults; such findings would be considered of routine diagnostic significance in case of adult LD assessment. It is often response to treatment that provides, a posteriori, the "proof"; while the adult with low literacy skills can often acquire and master high-level reading, writing, and arithmetic skills in a relatively short period of time, the adult LD may hope, at best, to improve his/her high-level study skills by acquiring and practicing compensatory strategies.[1]

Issues of study skills in adolescents and adults began to draw the attention of researchers (e.g., educators, psychologists) following World War II when large numbers of returning GIs enrolled in post secondary institutions. However, it was not until the mid-1970s, when issues of children's learning disabilities caught the attention of the general public, that specific tests for the assessment of study skills began to appear in the scientific literature. Many of those assessment procedures that were normed for children were later applied to adolescents and adults, usually without any modification or adjustment. Knowles (1970), one of the first researchers who advocated a different approach to adult learning, reminded his readers that "most of what is known about learning has been derived from studies in children and animals" (p. 37). Unfortunately, this is still true 25 years later. It was only recently that researchers began to realize that adult learners are different than children in several important aspects and began to develop assessment tools that are suitable for this population.

The number of students requesting service for learning disabilities at colleges and universities in Canada and the United States has increased manyfold over the past 10 years or so. In the absence of systematic surveys, it is difficult to obtain a reliable estimate for the actual numbers involved, but anecdotal evidence based on many conversations with service providers (e.g., Learning Disabilities Specialists and Coordinators of Special Services in many colleges and universities) point to numbers as high as 5% of the total student populations at universities and possibly even higher at colleges, with about half of these students reporting no earlier identification of LD. These numbers are consistent with results reported in recent studies of the prevalence of learning disabilities in Canadian schools (Canadian Council for Exceptional Children, 1988; Cummings, Hebb-Grier, Brazil, & Vallance, 1990; Siegel & Wiener, 1993). Similar results were reported in studies conducted in the United States (Brinkerhoff, 1991; Gajar, 1992; Vogel & Adelman, 1992).

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The definition of learning disabilities is an issue that keeps attracting the attention of researchers, as is evident by the large number of recent articles and chapters devoted to definitional issues (e.g., Hammill, 1990; Morrison & Siegel, 1991b; Rourke & Fisk, 1988; Shafrir & Siegel, 1994a; Siegel & Heaven, 1986; Swanson & Keogh, 1990; see Whole Number 4, Volume 14 of *Learning Disability Quarterly* [Fall 1991] for recent reviews). In 1981, the National Joint Committee for Learning Disabilities (NJCLD) offered a definition that described learning disabilities as "a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities" (Hammill, Leigh, McNutt, & Larsen, 1981, p. 336). This definition is based on the underlying assumption that learning disabilities are internal to the individual rather than due to extrinsic conditions such as lack of educational opportunities, insufficient instruction, cultural differences, and psychological factors; in other words, in order to be labeled *learning-disabled*, a person should both exhibit certain learning deficits and also do not possess certain ancillary conditions that may be viewed as possible or even probable causes of the learning deficits.

Over the years, this definition has been positively evaluated and has received strong support in the educational community. However, it is widely recognized as a conceptual statement that defines the construct of a learning disability but not its operational aspects. The practical aspects of identification and subtyping of learning disabilities are still the topic of a heated scientific debate (Swanson, 1991). These aspects include: choice of conceptually correct measures, linking definitions to neuropsychological evidence, choice of measures expected to exhibit a discrepancy, and methods of measuring a discrepancy. The specific issues of identification and subtyping of learning disabilities in the adolescent and adult population are further exacerbated by the dearth of published research in this field. This is most evident in the case of students in post-secondary academic institutions where systematic studies are only now beginning to appear in the scientific literature (Gajar, Salvio, Gajria, & Salvio, 1989; Runyan, 1991; Shafrir & Siegel, 1994a, 1994b). However, even these studies address only the issue of identification and subtyping of learning disabilities in university students and not issues of remediation. It is important to note that even an operational definition for the subtyping of learning disabilities that is based on specific deficits in academic achievement (Shafrir & Siegel, 1994) still leaves the important issue of remediation open.

This report reviews recent research on issues that are central to learning, learning disabilities, and study skills in seven important areas—reading and listening, writing, arithmetic, memory, metacognition, representational competence, and perceived competence. It is important to emphasize that this is not an exhaustive (nor even a comprehensive) review of the literature; rather, the review is selective and focuses on recent findings that have direct implications for the assessment and remediation of study-skill deficits in adolescents and adults.

Reading and Listening Comprehension

Although the acquisition of spoken language is a natural process shared by all humans, learning to read is an intentional, mediated learning experience that has only recently become normative in literate societies. The last 50 years or so have witnessed a dramatic increase in our knowledge and understanding of the psychological processes underlying text comprehension.

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The relationship between listening comprehension and reading comprehension was the subject of many studies (Danks, 1980; Durrell, 1969; see review by Sticht & James, 1984). These skills are similar in that both involve interpretation, evaluation, and comprehension of symbols—aural (spoken) symbols in the case of listening and graphic (visual) symbols in the case of reading. These commonalities gave rise to the unitary model of linguistic comprehension, which states that the ability to construct meaningful interpretations of language lie at the core of the two modalities, and that intermodal differences in comprehension result from differences at the input level (Danks & End, 1987; Sinatra, 1990; Sticht, 1979). Some researchers view reading comprehension as decoding plus listening comprehension (Carroll, 1977; Fries, 1963; Sticht, Beck, Hanke, Kleiman, & James, 1974) and have pointed out that the unitary model of comprehension would generate an expectation of comparable upper limits for optimal comprehension for rate of presentation of material (e.g., printed or spoken words). Indeed, research has documented the existence of a common upper limit (about 300 words per minutes at the college level; Aaron, 1989; Sticht, 1984).

A similar view was expressed by Hoover and Gough (1990) in what they called "a simple view of reading." They suggested that reading comprehension may be decomposed into decoding and linguistic comprehension and that deficits in one of them would result in deficient reading comprehension.

Assessment of Reading and Listening Comprehension

Sequential stages in the acquisition of reading skills follow the natural hierarchy of printed text—from word to sentence to passage. The same hierarchy is reflected in the recent history of reading research, where the emphasis shifted from decoding and memory of single words to sentence comprehension, to the comprehension of whole texts (Caplan, 1972; Kintsch & van Dijk, 1978; see reviews by Baars, 1987 and Meyer & Rice, 1984). Whereas, in the 1950s, most studies of reading used single words as stimuli, the development of a *propositional theory of reading* in the 1970s targeted processes involved in the comprehension of single sentences. A *proposition* is defined as the smallest unit of knowledge that can be stated as a separate assertion. A single word can never be considered as a proposition (e.g., sky, blue), but a sentence is a proposition (e.g., the sky is blue). Text, then, can be understood at the sentence level, but is this the only level for gleaning meaning from printed text?

More recent studies suggest that text comprehension is not achieved only at the level of individual sentences but rather is related to mental models of the whole text constructed by readers in real time (Johnson-Laird, 1983; Sanford & Garrod, 1981; van Dijk & Kintsch, 1983). "Readers not only process a text at a propositional level, they also construct a mental model that is analogous in structure to the events, situations, or layouts described by the text" (McNamara, Miller, & Bransford, 1991, p. 493). However, research has also shown that readers often process text either as a set of propositions or as a mental model, depending on the nature of the text and on task instructions (Garnham, 1981; Mani & Johnson-Laird, 1982). Readers seem to prefer propositional encoding when they anticipate a future need to recall the text verbatim or when the text is indeterminate (i.e., contains ambiguous relationships in space or in time). On the other hand, readers seem to prefer to encode meaning through mental models for text that is determinate (i.e., does *not* contain ambiguous relationships in space or in time). In such cases, the encoding of meaning in a mental model seems to result in better recall of the gist of the text as well as of main events described therein An intermediate way of encoding text may be through a *passage mental model* (O'Brien & Myers, 1987; Trabasso & van den Broek, 1985), where the causal relations among various propositions in the passage are encoded in addition to the individual propositions.

Text structure may play an important role in facilitating or impeding comprehension (Loman & Mayer, 1983; Mayer, 1985, 1987; Meyer, Brandt, & Bluth, 1980). Text structure refers to the internal organization of text and can be represented by an outline or a flowchart. For example, text structure of narratives differs from text structure used in expository writing (Graesser, 1981; Mandler & Johnson, 1977). Mayer and his associates investigated the comprehension of scientific text; they found that skilled readers were often unaware of the structure of scientific text and treated the text as a list of facts. Cook and Mayer (1988) reported that direct instruction raised the awareness of text structure, assisted readers in building a better mental representation of the text, and improved comprehension and recall.

Another variable that mediates comprehension of scientific text is the specific strategy used by the reader in studying the text. Castaneda, Lopez, and Romero (1987) investigated the effectiveness of the following five strategies on the resultant comprehension of three samples of chemistry text that varied in level of difficulty along these lexical and syntactic dimensions: repetition, paraphrasing, linking (i.e., elaborating temporal and causal links of concepts contained in the text), grouping of concepts by similarities and differences, and hierarchy (i.e., organizing the information on the basis of subordinate relations among concepts). Castaneda, Lopez, and Romero (1987) found that comprehension was the product of interaction between the nature of the text and the strategy used but found that linking was, overall, the most effective strategy.

Research has also shown that other text variables, such as referential coherence and plausibility, and reader variables, such as personality types and affective states, mediate comprehension and recall (Black, Freeman, & Johnson-Laird, 1986; Bower, Gilligan, & Monteiro, 1981; Johnson-Laird, 1983; McAllister & Anderson, 1991; Wilson, 1973).

The comprehension of text involves both automatic and strategic processes, which vary along six variables: speed, sensitivity to conscious expectations, costs and benefits, intentionality, capacity limitations, and trainability (McNamara, Miller, & Bransford, 1991). *Strategic processes* are slow, effortful, intentional, improve with training, and may produce both costs and benefits. Novice readers do not possess efficient automatic processing and have to rely on *low-level strategic processes* for the identification of single letters and for decoding whole words. They habitually respond to embedded cues to generate expectations regarding proximal text. Such expectations may result in enhanced or decreased comprehension, depending on the nature of the prime, which may be relevant, irrelevant, or in some cases, misleading. On the other hand, *automatic processes* are fast, effortless, and unintentional and produce benefits but few costs. Training in these processes usually does not increase the benefits. Expert readers use efficient automatic processes for phonemic awareness, rapid decoding, lexical access to large vocabularies, and knowledge about text structure; they also use high-level strategies, such as self-monitoring, that help to increase their comprehension (Baker & Brown, 1984b; Paris, Wasik, & Turner, 1991).

Reading and Listening Comprehension Skills in Learning-Disabled Students

Recent research showed that deficits in listening and reading comprehension often prove detrimental to the attainment of post-secondary educational goals (Royer, Lynch, Hambleton, & Bulgarelli, 1984; Royer, Marchant, Sinatra, & Lovejoy, 1990). Adolescents and adults with reading disabilities exhibit various deficits in the processing of print material, notably, in single-word decoding (e.g., sounding of single words and pronounceable letter strings; Aaron, 1989; Aaron & Phillips, 1986; Bruck, 1990; Shafrir & Siegel, 1994), slow reading rate (Runyan, 1991), poor spelling (Aaron, 1989; Aaron & Phillips, 1986), and poor reading comprehension (e.g., answering questions about text that has been read silently and aloud; Runyan, 1991). Several studies reported that reading disabilities in children and in adults are associated with phonological processing deficits, such as in phonemic awareness, phonemic confusability for rhyming stimuli, and the spelling of pseudowords (Bradley & Bryant, 1983; Lundberg, Frost, & Peterson, 1988; Mann, Lieberman, & Shankweiler, 1980; Siegel & Ryan, 1988). Several theorists attributed causal status to phonological deficits in reading disabilities (Siegel & Ryan, 1988; Stanovich, 1988; Velutino & Scanlon, 1987a; Wagner & Torgesen, 1987). Stanovich (1988) claimed that such a *core phonological deficit* is modular and not under the control of higher cognitive processes, and therefore cannot be remediated by increasing the efficiency of such higher processes. Results obtained with a new regression-based analytical model (Stanovich & Siegel, 1994) supported the predictions of the phonological-core, variable-difference model of reading disability, namely, that reading-disabled children, both with and without aptitude/achievement discrepancy, share a deficit in phonological processing and that differences between these two groups reside outside the word-recognition module.

Such results as reported by Stanovich and Siegel (1994) generate certain expectations regarding the characteristics of reading disabilities. The two most important ones are that (a) a reading disability should persist from early age through adulthood, and (b) IQ tests are irrelevant for the diagnostics and treatment of a reading disability. Research provides some support for these inferences. Follow-up studies with adults who were diagnosed as reading disabled in elementary school showed that early word-recognition deficits persisted through adulthood (Bruck, 1990; see also DeFries, Olson, Pennington, & Smith, 1991 and Wood, Felton, Flower, & Naylor, 1991). Other studies reported that it was more clinically and educationally relevant to define a reading disability without reference to IQ (Share, McGee, & Silva, 1989; Siegel, 1988, 1989).

Several researchers proposed that reading disability should be defined by a discrepancy between reading ability and listening comprehension (Aaron, 1989; Carroll, 1977; Durrell, 1969;

Gough & Tunmer, 1986; Royer, Kulhavy, Lee, & Peterson, 1986; Spring & French, 1990; Stanovich, 1991; Sticht & James, 1984). In presenting the case for such a definition, Stanovich (1991) pointed out that "listening comprehension correlates with reading comprehension much more highly than full scale or even verbal IQ" (p. 274). The rationale for a listening/reading comprehension discrepancy definition of reading disability may be summarized as follows. It is not surprising that a person who has difficulties in comprehending spoken language is not a good reader; on the other hand, a person who scores high on listening comprehension is also expected to score high on reading comprehension (Carlisle, 1989, 1991). Consequently, a large discrepancy between a low score on reading comprehension and a high score on listening comprehension should be regarded as an indicator of a specific (modular) decoding deficit, defined as a reading disability (Stanovich, 1988, 1991).

Writing Skills

Writing is an important high-level skill for adolescents and adults. At secondary and post-secondary institutions, writing is commonly viewed as one of the most important generic study skills and the main skill for the demonstration of mastery of knowledge. However, the central role played by writing skills is not confined to the lives of college and university students. In the post-industrial, information-based society, written communication is an important part of literacy skills and has become an element common to many job descriptions. A demonstrated skill in producing clear and concise written discourse is often the key to securing and keeping a desired job.

Researchers proposed various systems of categorization of writing in order to capture the multifaceted nature of this complex mental activity (Bereiter & Scardamalia, 1987; Hayes & Flower, 1980; Perl, 1983; Purves, 1991; Rose, 1984; Stotsky, 1990). These systems include a phenomenological approach (e.g., classification of activities involved in writing), process-analytical models (as distinct from product-based analysis), and a shift away from lower-level skills (e.g., spelling and the mechanics of writing) towards a focus on higher-level writing skills, such as planning, text structure, organization, recursive production cycles, and metacognitive processes (Bereiter & Scardamalia, 1987; Hayes & Flower, 1980; Meichenbaum, 1979; Morris-Friehe & Leuenberger, 1992; Newcomer & Barenbaum, 1991; Perkins & Brutten, 1990; Perl, 1983; Rose, 1984; Stotsky, 1990). However, several researchers found that the low-level skill of handwriting plays an important role in the analysis of written discourse. The quality of handwriting tends to affect evaluators' ratings. (Neatness of handwriting is sometimes positively correlated with high markings; Ochsner, 1990; Purves, 1992). In addition, slow production of handwritten words tends to interfere with the quality of the produced text. Several researchers believe that this is due, at least in part, to the effect of diverting critical mental resources (e.g., short-term memory) from the main task of producing a text of high overall quality to that of generating a legible script (Flower & Hayes, 1981a; Monahan, 1984; Nold, 1981).

Writing is not an external expression of existing thoughts, but a way of developing ideas and molding them into a new, integrated whole. Howard and Barton (1986) coined the phrase "thinking on paper" to describe writing and claimed that "thinking in writing is...a form of understanding...from first thoughts to the last word in writing, *articulation precedes communication*" (p. 13). Most experts agree that written discourse is the symbolic manifestation of a sequence of complex mental activities of meaning-making what we call thought (Bereiter & Scardamalia, 1987; Hayes, 1987; Hayes & Flower, 1980; Howard & Barton, 1986; Flower, 1993; Flower & Hayes, 1980a; Flower & Hayes, 1981a, 1981b; Johnson-Laird, 1983). Bereiter and Scardamalia (1987) characterized novice writers as *knowledge tellers*, who use cues in the writing assignment to activate a long-term memory *content space* of relevant information which they then use indiscriminately in the production of the text. In contrast, these researchers described expert writers as *knowledge transformers*, who, in addition to working with the content space, operate on a *rhetorical space* that controls, in a recursive manner, the production and modification of the written discourse.

Speaking and writing are both acquired skills; however, they are different in several important ways. In contrast to speech, a skill which is acquired automatically as a natural and integral part of a child's development, the acquisition of writing is deliberate. It has to be taught. Speech is a skill that is intimately tied to the here-and-now; the conversants are engaged directly in the joint construction of shared meaning. Consequently, real-time feedback and social cues often play important roles. On the other hand, written discourse is removed in time and space from its intended audience and uses abstracted, objectified syntactic and grammatical structures to convey meaning (Feldbusch, 1986; Olson & Hildyard, 1978; Smith, 1985; Stotsky, 1985; Vygotsky, 1978).

Assessment of Writing

Procedures for the assessment of writing differ greatly in their expected outcomes—the two extremes being the labeling of skill level and remedial instruction. The temporal sequence of most standardized writing assessments is the following: A writing assignment is given to the student by the instructor, the student produces text (often immediately, and often hands in first draft), the instructor marks text (often off school premises, almost always in private), and the student receives marked text from the instructor. This sequence reflects the prevailing and accepted role of the teacher as "handing down knowledge" and of the student as an inexperienced learner, the passive receiver of such knowledge (Beaugrande & Olson, 1991; Hillocks, 1986). The historical development of this teacher's role was informed by the literal meaning of *pedagogy*, the art and science of teaching children (a term constructed from the Greek words *paid* [child] and *agogos* [leading]).

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Taking an evaluative stance vis-à-vis a given text requires that the evaluator hold a clear perspective regarding the purpose as well as the expected outcome of the writing assessment (Beaugrande & Olson, 1991; Cooper & Odell, 1977). Writing can be viewed as linguistic behavior but also as social, psychological, and educational phenomena. Within each of these contexts, writing may be evaluated from various perspectives (e.g., administrative, instructional, research); and, within each of these perspectives, writing may be evaluated from an *atomistic* or from a *holistic* point of view (Cooper, 1981; Gajar, 1989; Otte, 1991).

Atomistic measures deal with various mechanical aspects of writing (that are also often easily quantifiable) such as punctuation, spelling, diversity of word usage, vocabulary, word counts, and syntactic maturity that may be measured in T-units (Gajar, 1989; Morris & Crump, 1982; Weiner, 1980). In contrast, holistic evaluation attempts to capture the overall impression of the written discourse by rating it on a number of scales designed to capture certain features such as text structure, reasoning, complexity, moral level, affect, organization, sequencing, and style (Cooper, 1977; Morris-Friehe & Leuenberger, 1992; Verhults, 1987; White, 1985; Wilkinson, Barnsley, Hanna, & Swan, 1980). One problem with holistic evaluation is that some of the aforementioned aspects of writing are *genre-sensitive*. For example, text structure may be judged differently if the text is transactional in nature (i.e., designed to transmit a utilitarian communication such as persuading, instructing, reporting, etc.) or expressive (i.e., describing inner mental experience through literary text; Donald, Morrow, Griffith, Wargetz, & Werner, 1989; Englert & Chase Thomas, 1987).

Writing Skills of Learning Disabled Students

Such assessment procedures offer little to students with learning disabilities who exhibit writing deficits that persist over time (see review by Graham & Harris, 1989) in such areas as the mechanics of writing, using text structure functionally, using knowledge-telling strategy to generate text, and using metacognitive strategy such as planning and monitoring (Barr Reagan, 1991; Chase Thomas, Englert, & Gregg, 1987; Englert & Chase Thomas, 1987; Gregg, 1983; Gregg & Hoy, 1989; Houk & Billingsley, 1989; Lynch & Dove Jones, 1989; Moran, 1981; Morris-Friehe & Leuenberger, 1992; Newcomer & Barenbaum, 1991; Otte, 1991; Shafrir & Siegel, 1994a; Shafrir, Siegel, & Chee, 1990; Tindal & Hasbrouk, 1991; Tindal & Parker, 1989). LD students are also not knowledgeable about the writing process and often overestimate the quality of their writing (Englert, Raphael, Fear, & Anderson, 1988).

Two instructional methodologies designed to improve the quality of writing of LD students have been applied successfully; they are: (a) *procedural facilitation*, where an external mediator provides cues, prompts, and so on to remind the writer to pay attention to various aspects of the writing process (Bereiter & Scardamalia, 1982; Graham, 1990; Scardamalia & Bereiter, 1986); and (b) *direct strategy instruction*, where the student learns specific strategies that help him/her improve the quality of the resultant text (e.g., self-monitoring of productivity, content generation, framing and planning of text, editing, and revising; Deshler & Schumaker, 1986; Graham & Harris, 1989; Harris & Graham, 1985; Schumaker et al., 1982; Wong, Wong, Darlington, & Jones, 1991).

Improving Adult Writing Skills

Improving the nonfiction writing skills of adults is a topic that recently attracted the attention of cognitive psychologists (e.g., Flower, 1993; Flower & Hayes, 1980a, 1984; Flower et al., 1990), adult educators (e.g., Axelrod & Cooper, 1993; Donald, Morrow, Wargetz, & Werner, 1989; Elbow, 1981; Howard & Barton, 1986; Reid, 1988; Rose, 1985; Sommer, 1989), and professional writers (e.g., Horgan, 1988; Zinsser, 1990). Flower and her associates developed a writing improvement program that is based on the view of writing as a problem-solving process—planning, generating and organizing ideas, building a thesis, designing prose for a reader, revising for purpose, and editing for style and clear organization (Flower, 1993). A similar approach was developed by Howard and Barton (1986), who claimed that a writer's angst may be overcome by showing the writer how to generate and refine ideas through writing. They built their instructional methodology on the premise that the essence of the complex relationships between writing, thinking, and communicating is captured by three propositions:

1. Writing is a symbolic activity of meaning-making.
2. Writing for others is a staged performance.
3. Writing is a tool of understanding as well as of communication. (p. 20)

Several new approaches to teaching writing to adults were developed by teachers of academic writing. Sommer (1989) begins by asking why adults should be taught differently and goes on to claim that the main reasons are that (a) adults generally exhibit a mature attitude toward education, are motivated to attain specific learning outcomes, and can draw on their past experience to support their learning; and (b) adults who return to school often have poor records from their earlier studies, feel less confident than younger students in their ability to achieve academic success, and are often distracted by economic and workplace- or family-related problems.

Zinsser (1990) addresses key issues in writing from the point of view of a professional writer. He views clear thinking as "a conscious act that writers must force upon themselves." He analyzes simplicity of expression and advocates freedom from clutter:

> [T]he secret of good writing is to strip every sentence to its cleanest components. Every word that serves no function, every long word that could be a short word, every adverb that carries the same meaning that's already in the verb, every passive construction that leaves the reader unsure of who is doing what—these are the thousand and one adulterants that weaken the strength of a sentence. (p. 7)

Arithmetic Skills

Mathematics instruction in Canada and the United States has recently undergone fundamental changes, prompted by the publication of revised Curriculum and Evaluation Standards for School Mathematics (e.g., National Council of Teachers of Mathematics, 1989; National Council of Supervisors of Mathematics, 1989). The new standards cover *numeration* (i.e., understanding of number concepts, number sense and usage, and place value), *computation* (i.e., fluent and accurate completion of problems in addition, subtraction, multiplication, and division), *estimation* (i.e., "producing an answer that is sufficiently close to allow decisions to be made"; Reys, 1986, p. 3), *fractions and decimals* (e.g., equivalent fractions, multiplying and dividing mixed fractions), *measurement* (e.g., recognition of standard units of measurement, selection of the appropriate unit, estimation, and application to everyday situations), *geometry* (e.g., shapes, patterns, geometric relationships, properties of figures), and *problem solving* (e.g., reasoning, strategy choices, the selection and application of appropriate rules).

However, changes in the way mathematics is being taught at school are not limited to content (i.e., what is taught). The methodology of teaching math has also changed (e.g., activities with concrete material, discovery of rules, small-group work and individualized learning) as have the instructor-student relationships (e.g., less formal, purposive work with minimal external controls).

The sequencing of curriculum material is based on the widely recognized fact that mathematical skills are hierarchical in nature (Mayer, 1986)—numeration (e.g., number readiness) must precede arithmetic computation (e.g., concrete manipulations of numbers) which, in turn, must precede algebraic computation (e.g., generalization of arithmetic computation, symbolic manipulations of variables). Solving mathematical problems is a high-level skill that depends on the integration of well-rehearsed lower-level skills. Deficits in any of these low-level skills inevitably results in a deficient skill of mathematical problem-solving.

Affective issues in mathematical problem solving is an emerging topic that recently began to attract interest among researchers and practitioners (Buxton, 1991; McLeod, 1988). McLeod describes examples of students who get frustrated in the process of attempting to solve a nonroutine problem and quit. McLeod suggests that integrating affective aspects into instructional methodologies in mathematics may help in making students aware that, for example, "getting stuck" is a normal part of mathematical problem solving and should trigger a scheme of "look for another way" or "ask for help," rather than "quit." Early problems in arithmetic and the resultant experience of repeated failure are often transformed into "math panic" at a later age, a phenomenon that is unfortunately familiar to many adolescents and adults. This should not be confused with an arithmetic disability; however, it is worthwhile to notice the growing awareness that practitioners should be responsive to such fears and alleviate the negative affect that is often associated with this academic domain (see Buxton, 1991).

Improving Mathematical Problem-Solving Skills

Interest in improving mathematical problem-solving skills prompted research in the area of cognitive arithmetic during the past decade (e.g., Davis, 1992; Mohanna & Al-Heeti, 1989; Owen &

Sweller, 1989; Schommer, Crouse, & Rhodes, 1992; Sfondilias & Siegel, 1990; see reviews by Ashcraft, 1992; Nesher, 1986; and Pressley, 1986). Ashcraft reviewed the empirical data on problem size/difficulty, error effects, relatedness effects, and processing strategies, and described current models of arithmetic processing. An emergent theme in several of these studies is the realization by researchers that the traditional emphasis in teaching on mathematical symbols should be changed to focusing on the representation of meaning of mathematical concepts (e.g., Davis, 1992). The role of thematic context in facilitating representation of mathematical problems and improving understanding was the topic of a study by Ross, McCormick, and Krisak (1986). They reported that education majors and nursing majors learned best from mathematical problem solving couched in educational and medical contexts, respectively. Ross, McCormick, and Krisak (1986) concluded that abstract formulation of mathematical problems leads to rote memorization of formulas and solution steps. They also concluded that a formulation in an unfamiliar context is distracting because of the learner's inexperience with the terminology and because of his or her inability to separate critical content from extraneous information.

Arithmetic Skills and Learning Disabilities

Until recently, learning disabilities were regarded as synonymous with reading deficits, and poor arithmetic skills were mostly ignored by educators (Rourke, 1985). However, there is evidence that in the school-age population, the majority of LD students have difficulties in arithmetic, that, in about 26% of the LD population, arithmetic is the primary deficit, and that about 6% of school-age children may be arithmetic-disabled (McLeod & Armstrong, 1982; Weinstein, 1980). Indeed, recent studies showed that arithmetic-disabled students form a relatively homogeneous group within the heterogeneous LD population (Shafrir & Siegel, 1994a; Siegel & Heaven, 1986; Spellacy & Peter, 1978). Shafrir and Siegel (1994a) reported that arithmetic-disabled adults (e.g., good readers who scored at or below the 25th percentile on the Arithmetic sub-test of the WRAT-R) showed significant deficits in memory and in visual-spatial processing. However, this study also documented the relationship between language deficits and arithmetic problems. An experimental group of adults with reading *and* arithmetic deficits (e.g., scores at or below the 25th percentile on both the reading and arithmetic sub-tests of the WRAT-R) scored more poorly than the control group of nondisabled adults as well as the other two experimental groups (i.e., reading-disabled without arithmetic problems and arithmetic disabled without reading problems) on most measures of intellectual functioning and academic achievement (Shafrir & Siegel, 1994a). These results support the view that there exists an interaction between language and mathematical skills. This is not surprising considering the widely recognized fact that, beginning at an early age, language plays a crucial role in the acquisition of mathematical concepts (Aiken, 1972; Earp & Tanner, 1980) and considering the similarities between the properties of mathematics and those of formal languages (Beilin, 1975; Sharma, 1981).

Recent research attempted to uncover the specific cognitive processes that may underlay arithmetic disability (see reviews by Morrison & Siegel, 1991a and Smith & Rivera, 1991). Three approaches to the construction of explanatory models of arithmetic disability may be discerned.

1) The *fixed rule approach* is based on the assumption that errors in computational arithmetic are not random but systematic and that such errors result from the internalization by the arithmetic-disabled student of incorrect rules. According to this approach, the (correct) application of an incorrect rule will result, of course, in consistent error patterns (e.g., Ashlock, 1976; Brown & Burton, 1978; Brown & VanLehn, 1980; Young & O'Shea, 1981).

2) The *contextual approach* states that arithmetic computation and arithmetic problem solving are not context independent as claimed by proponents of the fixed rule

approach (which states that rules are both internalized and applied in a decontextualized manner) but rather that context plays an important role, namely, that procedure selection depends not only on the type of problem to be solved but also on the context in which it has been presented (e.g., recent problem-solving activities; Linder, 1985).

3) Several researchers developed the *mental arithmetic model approach*, which states that error analysis and contextual clues are insufficient to explain cognitive processes underlying the documented poor arithmetic skills of arithmetic-disabled students.

These researchers believed that a detailed, step-by-step computational arithmetic model based on the additive model of Sternberg (1969) was needed in order to arrive at a reconstruction of the actual procedures used by those students. Indeed, reported results for mental addition showed that an initial mental model of step-by-step addition used by young children is replaced by grade 3 with a fast direct-retrieval memory strategy similar to the one used by adults (e.g., Ashcraft, 1982; Geary, Widaman, Little, & Cormier, 1987). According to the mental arithmetic model approach, the shift from the counting strategy to the fast direct-retrieval memory strategy is delayed in arithmetic-disabled children until grade 8. It appears that, even in later years, arithmetic-disabled students are significantly slower than their nondisabled peers in performing arithmetic computations.

Several studies investigated the issue of improving the mathematical problem-solving skills of students with learning disabilities (Case, Harris, & Graham, 1992; Corn, 1987; Hutchinson, 1987; Wilson & Sindelar, 1991; see reviews by Goldman, 1989 and Montague, 1988). There is evidence that LD students often rely on trial and error in mathematical problem solving rather than attempt to apply a systematic strategy (Montague, 1988). A common thread in several of these studies is the recognition of the importance of focusing on the way in which the learning-disabled student represents the problem rather than relying on the standard checklists for strategy application (e.g., Goldman, 1989; Hutchinson, 1987).

Memory Skills

Memory, the ability to encode, retain, and retrieve information over time, is universally regarded as a resource that plays an important role in most mental activities. Since learning requires the integration of new information into an existing knowledge base, it is not surprising that good memory skills are essential for learning.

The development of memory from birth to adulthood has been the subject of intense research over the past fifty years or so (see Kail, 1990 for a recent review). Developmental psychologists in the Piagetian tradition sometime refer to short-term memory (STM, i.e., the ability to hold several unrelated pieces of information in mind while searching for an answer or a solution) as M-capacity (Mental capacity) and view the course of its increase over time as one of the most important constraints on cognitive development (Case, 1985; Pascual-Leone, 1984). Other researchers challenged the idea that M-capacity changes with age (Chi, 1976; Schneider & Pressley, 1989). Studies showed that memory depends on other factors such as strategies, chunking, metacognitive knowledge, domain-specific knowledge, and reasoning abilities (Carey, 1985; Flavell & Wellman, 1977; Schneider & Pressley, 1989; see Halford, 1993, for a recent review).

In addition to STM, the two other types of memory that are often referred to in the literature on learning are long-term memory (LTM) and working memory (WM). LTM is the ability to encode and retrieve information over long periods of time; LTM provides the knowledge context for learning (i.e., the underlying structure for the understanding and encoding of new information).

WM is the ability to mobilize and allocate memory resources for the processing of the task at hand. Cognitive functioning is widely viewed as being constrained by the immediate availability of mental resources for the various, and often competing, task demands (e.g., the amount of mental energy required for performing a given task; Kahneman (1973) proposed a model where demands of the task determine the allocation of mental resources in an automatic process driven by features of the stimulus rather than by the subject's intent). WM is viewed by many researchers as a critical resource that plays an important role in determining learning outcomes (for a review, see Hasher & Zacks, 1988).

Metamemory

Metamemory refers to the knowledge that individuals have about their own memory (Borkowski, Peck, Reid, & Kurtz, 1983; Cavanaugh, Grady, & Perlmutter, 1983). Several studies investigated the relationship between metamemory, memory, study strategies, and performance (Carr & Borkowski, 1987; Cornoldi, Gobbo, & Mazzoni, 1991; Devolder & Pressley, 1989; Fatal & Kaniel, 1992; Justice & Weaver-McDougall, 1989; Leal, 1987; Short, Schatschneider, & Freibert, 1993; see reviews by Moely, Hart, Santulli, Leal, Johnson, Rao, & Burney, 1986; and Pressley, Borkowski, & O'Sullivan, 1984). In general, such studies reported positive but modest correlations between metamemorial knowledge (based on self-reports) and performance on academic tasks. For example, in a study of the influence of metamemory on transfer in sixth-graders, Fatal and Kaniel (1992) concluded that "instruction of metamemory is a less powerful potentiator of transfer than instruction of specific strategies...[S]trong relationships between aspects of metamemory and memory behavior have been generated when process rather than performance measures have been recorded" (p. 99).

A recent study on the metamemorys of memory researchers cast an even graver doubt on the hypothesis that metamemorial knowledge is positively related to performance through the use of more effective memory strategies. Park, Smith, and Cavanaugh (1990) investigated metamemorial knowledge and the memory strategies actually used by academics; they administered a metamemory questionnaire to psychologists who specialize in memory research—academic psychologists with limited knowledge of memory; and nonpsychologist college professors. Park, Smith, and Cavanaugh (1990) reported that there were few differences between memory experts and nonexperts in the type of memory strategies that they used and recommended for others to use. Notably, these tended to be dependent on external aids (e.g., notes and lists). In particular, there was no evidence that even memory experts used formal mnemonic systems with which they were familiar through their research, notwithstanding the fact that "memory experts are somewhat more likely to cite their professional knowledge as the basis for their recommendations" (p. 325).

Working Memory and Discourse Comprehension

Of the various aspects of memory mentioned above, working memory in the context of discourse comprehension is one of the most important generic study skills (Daneman & Green, 1986; Just & Carpenter, 1987; LaBerge & Samuels, 1974; Stanovich & West, 1983). Working memory bears the burden of mobilizing, allocating, and orchestrating memory resources "and enabling the multiple processes that co-occur to make skilled comprehension possible" (Hasher & Zacks, 1988, p. 196). It is a resource that plays a critical role for drawing inferences from text and from orally presented information, as well as in understanding the meaning embedded in representational systems other than natural languages, such as mathematics, music, and other non-alphanumeric symbol systems.

Recent research showed large differences in working memory depending on age (e.g., Light & Burke, 1988; Light & Capps, 1986). However, level of education and verbal ability in adults seem to have a strong effect on the deterioration of discourse comprehension with age (Hulch & Dixon, 1984; Hultch, Hertzog, & Dixon, 1984; Zelinski & Gilewski, 1988). There is evidence that the moderating variable is the ability to construct and utilize efficient processing strategies (Carpenter & Just, 1988; Cohen, 1988; Perfetti, 1985; Zacks, Hasher, Doren, Hamm, & Attig, 1987).

Recent research provided support for the view that working memory is a malleable resource that may be effectively used to control such aspects of metamemory as memory monitoring through direct metamemory strategy instruction (Shaw & Craik, 1989).

Memory and Learning Disabilities

Since memory skills are inseparable from intellectual functioning, individuals lacking such skills can be expected to develop deficits in various academic domains (Stanovich, 1986; Swanson, 1991; Torgesen, Raskotte & Greenstein, 1988). Indeed, recent research documented significant memory deficits in adults with learning disabilities (e.g., Shafrir & Siegel, 1994a).

In order to understand the nature of memory-skill deficits of LD, it is important to distinguish between four types of memory-related processes—namely, sensory input (e.g., encoding), short-term memory, long-term memory, and working memory.

Studies showed that learning disabled students were not deficient in the encoding stage of word recognition compared to their non-disabled peers (Elbert, 1984; Lehman & Brady, 1982; Manis, 1985; Morrison, Giordani, & Nagy, 1977; Samuels, 1987; Swanson, 1983b).

In contrast to the encoding stage, LD students were shown to have deficits in STM; however, the exact nature of these deficits is still the subject of debate and much research (Cooney & Swanson, 1987). Contributing factors may include deficiencies in rehearsal (Bauer & Emhert, 1984; Dawson, Hallakan, Keeve, & Ball, 1980; Haines & Torgesen, 1979; Koorland & Wolking, 1982), elaboration of items to-be-remembered (Gelzheiser, Solav, Shephard, & Wozniak, 1983); and phonological coding errors (Johnson, Rugg & Scott, 1987; Shankweiler, Liberman, Fowler, & Fischer, 1979; Siegel & Linder, 1984; Sipe & Engle, 1986; Torgesen, 1988).

LTM deficits in learning disabled students have been documented in several studies (Ceci, 1986; Swanson, 1986; Vellutino & Scanlon, 1987b). These deficits have been attributed to various causes, including inefficient use of rehearsal strategies for storage (Tarver, Hallahan, Kauffman & Ball, 1976; Torgesen & Goldman, 1977), inefficient retrieval strategies (Wong, 1982), and deficient integration of multi-modal inputs into LTM (Ceci, Ringstron, & Lea, 1980; Swanson, 1984, 1987).

Working memory, crucial for the understanding and elaboration of text, involves the tasks both of processing sensory inputs and of retrieving and processing stored information. The results of a recent study by Swanson (1989) suggest that WM of learning disabled readers was deficient compared to non-disabled readers. Finally, deficits were also found in the executive control of memory-related strategies in LD student (Palincsar & Brown, 1984; Pressley, Johnson, & Symons, 1987; see Pressley, Symons, Snyder, & Canglia-Bull, 1989, for a recent review).

Improving Memory Skills

Memory may be enhanced through intervention techniques that target specific memory skills for the encoding and retrieval of information (Ascherman, Mantwill, & Kohnken, 1991;

Best, 1993; Rao & Moely, 1989). In a recent developmental study, 2nd and 7th graders and college students were shown a videotape of a model learning a list of paired-associate nouns via both an effective elaboration strategy and an ineffective rote-memory strategy. Results showed that the 7th graders benefited most from the exposure to the videotape; 2nd graders did not benefit, whereas college students demonstrated effective strategy selections even without vicarious test experience.

The two main classes of intervention for enhancing memory skills are mnemonics and non-mnemonic techniques. *Mnemonics* refer to memory strategies that use imagery and associations to enhance recall (Craik & Jacoby, 1979; Hersey, 1990; Lorayne, 1990). Some mnemonic strategies tend to be stimulus-specific. In other words, they are tailored for such stimuli as word pairs, names, and so on (Hersey, 1990).

Non-mnemonic techniques are strategies that are designed to enhance memory by optimizing aspects of learning that are known to be closely related to performance on memory tasks (Charness, 1981; Devolder & Pressley, 1989; Loewen, Shaw, & Craik, 1990). These aspects include strategies to enhance study habits and encoding efficiency, strategies for the reduction of anxiety, and strategies that minimize the encoding of irrelevant input.

Various strategies were used to enhance memory skills of LD students (Harris, Graham, & Freeman, 1988; McLoone, Scruggs, Mastropieri, & Zucker, 1986; Moely et al., 1986; Swanson & Cooney, 1991). They include rehearsal, elaboration, orienting attention, transformation, categorizing, the use of imagery, and metamemory.

Representational Competence

The ability to use alternative representational systems in decoding, processing, and encoding information is intimately related to the development of intellectual functioning. This ability is defined as representational competence, the fluency and flexibility to operate on different representational systems that conserve the meaning of an external experience. "[T]he *understanding and utilization* of a fundamental rule to the effect that knowledge presented in various forms (e.g., pictures, words, signs) still retains its intrinsic meaning in spite of variations in form of presentation" (Sigel, 1991, p. 189). The ability to represent experiences is intrinsic to the neural development of the individual. This ability is not necessarily realized but must evolve as a function of specific social dialogic experiences. Since individuals have different types of experiences in the course of development, they evolve different levels of representational competencies in various domains of experience.

Learning is closely related to the ability to form symbols and to represent information (Dondis, 1973; Kaplan, 1955; Werner & Kaplan, 1967). Newly acquired knowledge is not just mechanically added to existing knowledge but is encoded through complex processes of structuring and restructuring of experience. From a Piagetian perspective, the structuring-restructuring activity is akin to assimilation-accommodation processes. These changes in understanding occur as a consequence of physical and social action with objects and persons. It is through the course of such experience that the individual constructs meaning which forms the basis for his understanding of his environment. The child proceeds through a process of differentiation to organize experiences into different categories on the basis of their relative equivalence by noting that certain items/events share some common features. Thus, equivalences can be conceptualized in terms of meaning—conventional meaning and personal meaning. For example, a conventional meaning of an automobile can be "a means of transportation," represented in a picture or a word or some other symbol which can be universally understood in a particular culture. On the other hand, a personal meaning of the same automobile may be categorized as "a dangerous machine." Although formally depicted in the same way, the conventional and personal meaning of the symbol may be different.

A representation is a mental model of a distal event (or a distal object), an event/object that is removed in space and/or in time. A representation encodes the essential information of such a distal event and preserves its meaning beyond the here and now. Piaget (1962) defined representation as "the symbolic evocation of absent realities" (p. 67), and Halford (1982, 1993) suggested that an act of understanding results from a representation that is structurally isomorphic to the problem at hand. Different representations acquire their meanings by the functional roles they play within a network of interacting representations (Lloyd, 1989).

Meaning is derived through a process of abstraction, where the stimulus characteristics of the signs become redundant (Osgood, 1952). A meaning-preserving representational transformation is a shift from one representational system to a different representational system, where the two representations convey the same meaning. A meaning-preserving transformation is transparent to the stimulus characteristics of the signs of the two representational systems. However, Bakhtin (1993) claimed that no system of symbolic representation that uses finite building blocks to convey meaning (e.g., words in natural languages) can successfully capture the complete meaning of a flowing, continuous psychological experience. According to Bakhtin a linguistic abstraction of a psychological experience may capture some aspects of that experience but not the whole experience.

Assessment of Representational Competence

Methods for assessing representational competence were described by Sigel and his associates beginning in the early 1950s (Sigel, 1953, 1974; Sigel & McBane, 1967; Sigel & Olmsted, 1970). Sigel reported that pre-schoolers who came from families of lower socio-educational status had more difficulty in classifying pictures of objects than in classifying the "real" (e.g., 3-dimensional) objects themselves, while middle-class children did not exhibit such difficulties. Other studies have shown that several other factors may facilitate—or hinder—the development of representational competence, such as parents' educational background, parenting style, and the extent of psychological distancing used by the mediator/care-giver in instructional situations (e.g., the mental distancing from the here and now in encoding and processing of new knowledge; Sigel, 1982; Sigel & Cocking, 1977).

Similar results were found in older subjects as well as in other content domains, notably mathematics. Domain-specific knowledge may be tested directly by asking the subject to demonstrate mastery through rule application (e.g., in reading, writing, solving arithmetic problems), or indirectly by asking the subject to demonstrate the ability to preserve the meaning of an abstract concept (e.g., verbal, arithmetic) through the execution of meaning-preserving transformations, the use of alternative representational systems that may lie within or outside of the domain in question. For example, the arithmetic concept "fraction" may be expressed numerically (e.g., 1/2, 0.5, 50%), or by other linguistic means (e.g., natural language: one-half, fifty percent); in musical notation (e.g., 4/8; 3/4), or visually (e.g., partial shading of a regular polygon). Students in primary, secondary, and post-secondary institutions, who demonstrated competence in the application of mathematical rules in areas such as proportional reasoning, solution of algebraic equations, solution of word problems, and problems of rational numbers, performed below their expected level when asked to solve similar problems that were presented in an alternative format, including a format of realistic problem-solving situations (Fuson, Fraivillig, & Burghardt, 1992; Keating & Crane, 1990; Lesh, Behr, & Post, 1987; Lesh, Landau, & Hamilton, 1983; Miller, 1992; Moore, Dixon, & Haines, 1991).

Other studies showed that "mathematically sophisticated" college students failed to conserve the meaning of simple English sentences when asked to translate the sentences into mathematical notation (e.g., Clement, 1980; Kaput & Clement, 1979). Lockhead (1982) reported that a high proportion of faculty (university professors and high school teachers) failed similar tests, and concluded that "wrong answers are often selected because they best fit the subject's concept of mathematics. This implies that, rather than conveying no information, equations often convey misinformation" (p. 34).

Another strand of research investigated the concept of a general comprehension skill (Gernsbacher, Varner, & Faust, 1990). This concept evolved from the unitary model of linguistic comprehension which followed many reports of strong commonalities between reading and listening comprehension (e.g., correlations in the 0.70–0.80 range; Danks, 1980; Durrell, 1969; Palmer, MacLeod, Hunt, & Davidson, 1985; see review by Sticht & James, 1984). Gernsbacher et al. (1990) tested university students on comprehension of stories presented through three different input forms, linguistically or nonverbally, as well as in different modalities (in written form, auditorily, and through pictures); they reported correlations in the range of 0.70–0.90 between the these three forms of presentations and concluded that, "[i]n many domains, comprehension requires building a coherent mental representation of the information. And in many domains, individuals differ in their skill in building this representation" (p. 441).

Representational Competence and Learning Disabilities

There has been little research on the issue of representational competence of learning disabled university students. However, well-documented deficits in various academic domains in adults with learning disabilities (e.g., Shafrir & Siegel, 1994) gave rise to expectations of deficits in representational competence in those domains. Shafrir and Sigel (1994) examined the relationship between the representational competence of text and both low-level (e.g., single word decoding) and high-level reading skills (e.g., reading comprehension) in two groups of university students, reading disabled (RD) and normal readers (NR). Of particular interest was the ability of the students to distinguish between the two levels of representation involved in text comprehension—namely, the surface level (e.g., the morphological appearance of a sentence) and the deeper level of the meaning conveyed by the text. This study demonstrated a specific application, in the domain of reading, of the general construct of representational competence (e.g., the recognition that events can be the same in appearance and different in meaning or different in appearance and similar in meaning). Shafrir and Sigel (1994) operationalized representational competence of text as the ability to recognize meaning equivalence in text samples that varied syntactically or grammatically. The main task was a ten item pencil-and-paper test of representational competence of text (RCT). Each item contained five sentences. The subject was told that at least two of the five sentences mean the same thing and was asked to mark same-meaning sentences. In addition to the main task and the Woodcock Word Attack each subject was administered the following tests: WAIS-R, WRAT-R (reading), GORT-R, and the Nelson-Denny Test (reading comprehension). The procedure for administering the Nelson-Denny was as follows: after the normed time of 20 minutes, the answer sheet was marked and the subjects were told that they could continue for as long as they needed to complete the test. This procedure yielded the following measures: score (in percentile) at 20 minutes, score (in percentile) at own time, and own time (minutes). A commonality analysis revealed that RCT accounted for a significant amount of unique variance only for Nelson-Denny (own time) but not for GORT-R (where IQ accounted for a large portion of the variance) or for the 20 minute Nelson-Denny (where single word decoding accounted for a large portion of the variance). Of the three tests of reading comprehension, only the Nelson-Denny (own time) captured the maximal level of performance. In this modification of the Nelson-Denny test subjects were not expected to react immediately to the stimuli (as in GORT-R), or were they limited in time (as in the original 20 minute Nelson-Denny), but they could take as long as they needed to contemplate the correct response. Shafrir and Sigel (1994) claimed that RCT is not just another measure of reading comprehension or a correlate of IQ but that it is also a measure of the ability to recognize equivalence in meaning among text samples that may vary along syntactic and grammatical dimensions. This exploratory study showed that representational competence of text is an important measure: it captures a fundamental aspect of development that is differentiated, on the one hand, from the general level of intellectual functioning, and from domain-specific expertise in reading on the other.

Metacognitive Strategies

A discussion of metacognitive strategies must begin by clarifying definitional issues regarding differences between skills, strategies, and metacognitive strategies. This necessity stems from the lack of agreement among researchers regarding these definitions (e.g., Derry & Murphy, 1986; Levin, 1986; Weinstein & Mayer, 1986). In this section, we will follow an approach that draws the demarcation lines between skills, strategies, and metacognitive strategies according to two criteria—namely, generality and intentionality (Baron, 1981, 1985, 1988; Paris et al., 1991). At the lowest rung of the ladder of generality are *skills*, defined as automated information processing procedures (schemas) that are applied unconsciously by the learner to tasks within a specific content domain. Examples of skills are eye-hand coordination, grasping, letter recognition, and sound blending in single-word decoding. A *strategy* is the habitual way in which a learner deals with a certain class of learning tasks; it is a higher-level schema, cued by situational features of the task, that integrates at least some (and often many) lower-level skills within a single, goal-driven action plan (Case, 1985). Paris et al. (1991) described strategies as "actions that are selected deliberately to achieve particular goals" (p. 611), that are "open to inspection" by the learner (as well as by external mediators) and can thus be inspected and improved. Since types of learning tasks vary across skill domains (e.g., writing; reading comprehension; arithmetics), learners may be characterized by the type of strategy that they use in a given skill domain (e.g., readers who prefer visual strategies versus those who use phonetic strategies; see Shafrir & Siegel, 1994). However, task variables such as misleadingness and inclusion of irrelevant information may affect strategy choices and task performance (Culross & Davis, 1989). Finally, *metacognitive strategies* are intentional generic action-plans that (a) reflect knowledge of one's own learning, (b) are aimed at optimizing learning outcomes, and (c) are applicable across domains (e.g., Brown, 1980, 1987; Flavell, 1976, 1987; Flavell & Wellman, 1977; Garner & Alexander, 1989; Iran-Nejad, 1990; McCombs, 1989; Palincsar, 1990; Paris & Winograd, 1990). Examples of Metacognitive strategies are review of task demands, choice of appropriate strategies, and self-monitoring of understanding and of progress towards task completion. Such commonalities in task behavior do not characterize the learner as a user of a specific strategy in a specific domain but rather as a whole learner.

The distinction between skills, strategies, and metacognitive strategies may be also be made by using the pair of bipolar opposite concepts of *automaticity* and *control* (Schneider, Dumais, & Shiffrin, 1984). At one pole are skills, automatic processes that are evoked in an effortless, unconscious, and involuntary manner. For example, in the Stroop color-naming task (Stroop, 1935) the subject is asked to read a printed color name; if the word "GREEN" is printed with red ink, younger subjects show large interference. That is, they will say the word "RED" instead of "GREEN." Developmental studies have shown that this interference diminishes as reading competence increases (e.g., Schiller, 1966; Schadler & Thissen, 1981). The implication is that increased competence requires not only automaticity but also more control. We shift, then, to the opposite pole of control; here reside metacognitive strategies, which may be viewed as executive control schemas acting to regulate performance across content domains through awareness and intentionality.

Research has shown that learners exhibit commonalities in the self-regulation of behavior across domains (see review by Zimmerman, 1990; as well as whole of Vol. 25(1), of *Educational Psychologist*, 1990). Self-regulated learning has also been labeled *intentional learning* (Bereiter & Scardamalia, 1989), *reflective learning* (Baron, 1981; Dewey, 1933), and *mastery learning* (Dweck, 1986; Dweck & Leggett, 1988). Expert learners, in contrast to novice learners, have been shown to use well-developed metacognitive strategies that fall into the following broad categories: (a) Review the problem at hand and determine the level of difficulty involved prior to deciding on a plan of attack (Brown, Armbruster, & Baker, 1986; Chi & Bassok, 1989; Garner, 1987; Schoenfeld, 1987; Sternberg, 1988), (b) develop an hypothesis and a plan to test it by setting specific goals (Baron, 1988; Schoenfeld, 1987; Sternberg, 1988), (c) monitor their understanding and their progress (Anderson & Roth, 1989; Baron, 1988; Bereiter & Bird, 1985; Brown, Armbruster, & Baker, 1986; Garner, 1987; Schoenfeld, 1987; Sternberg, 1988), (d) pay close attention to failure feedback, review action plans, and "debug" faulty schemas (Shafrir, Siegel, & Chee, 1990; Shafrir, Ogilvie, & Bryson, 1990; Shafrir & Pascual-Leone, 1990), and, finally, (e) after the task has been completed, expert learners review their accomplishments, reflect on the new learning, and restructure their knowledge base to incorporate the new learning (Anderson & Roth, 1989; Baron, 1988; Schoenfeld, 1987). Several researchers claim that private speech plays an important role in facilitating the execution of these metacognitive strategies (Harris, 1990; Iran-Nejad, 1990; Rohrkemper, 1986; see review by Harris, 1990).

There are several methodological issues that cast doubt on the validity and reliability of studies of strategy use. One such issue concerns the ability of younger subjects to provide reliable reports on their mental processes. This includes the category of studies conducted with young children who may not be aware of their own mental processes or may lack the vocabulary to articulate their perceptions of their own learning (Baker & Brown, 1984a; Brown et al., 1986; Markman, 1985). These difficulties may be circumvented by contrasting interview data with observations of overt behavior during task engagement (Shafrir & Eagle, in press; Siegler & Jenkins, 1989). However, this issue is not limited to young children but generalizes to the question of reliability of verbal reports of strategy use by adults (e.g., think-aloud protocols, observations and videotaping of learning situations, and post-performance interviews; Bereiter & Bird, 1985; Schoenfeld, 1987; Siegler & Jenkins, 1989; Shafrir & Eagle, in press; Swanson, 1990a). An analysis of the pitfalls of self-report data that emphasized the need to corroborate such data with other experimental measures was offered by Garner (1988) who raised the interesting (and disturbing) possibility that subjects sometimes may tell "more than they know."

Effectiveness of Strategies

The widely accepted belief that expert learners use better strategies (domain-specific as well as metacognitive; see review by Gick, 1986) begs the question: What makes one strategy better than another strategy? The circular nature of the obvious answer (i.e., "the one that produces better results") raises the interesting possibility of defining objective yardsticks for measuring the relative effectiveness of different strategies. One such yardstick is the *information gain function* where the effectiveness of two strategies is compared by computing the expected score of each strategy relative to a strategy of random choice (Shafrir & Zangrilli, 1993). The twin issues of the availability of specific, behavioral (e.g., non-self-report) measures of strategy use, and the effectiveness of specific strategies are in dire need of development and clarification through future research.

The definition of metacognitive strategies as commonalities of intentional task behavior across content domains does not, of course, preclude studies of self-regulated learning within a particular domain. To the contrary, such studies have shed light on differences between experts and novices in several areas of learning, notably in reading comprehension and in math and science.

Metacognitive Strategy Use in Reading Comprehension

Reading comprehension, unlike single word decoding, is a high-level skill which involves the integration, in real time, of recently decoded text with relevant knowledge stored in long-term memory (Just & Carpenter, 1980; see review by Perfetti & Curtis, 1986). Research showed that expert readers use a variety of metacognitive strategies when processing text (see reviews by Baker & Brown, 1984a; Garner, 1987; Paris, Wasik, & van der Westhuizen, 1988). In contrast to novice readers who often concentrate on decoding single words and who seldom monitor comprehension, expert readers use phonemic awareness for automated, rapid decoding, have access to large vocabularies, and mobilize a wide repertoire of strategies to aid and improve comprehension (e.g., evaluate the author's intent, set the text in a broader context, and look for inferred meanings; Baker & Brown, 1984a, 1984b; Wineburg, 1991). Scott, Wasik and Turner (1991) claim that strategic reading is at the core of reading expertise and that the hallmark of expert readers are the twin metacognitive strategies of *awareness* and *regulation* (or *self-appraisal* and *self-management*, Brown, 1987; Paris & Winograd, 1990). Paris, Wasik and Turner (1991) offer the following six reasons to support this claim:

1. Strategies allow readers to elaborate, organize, and evaluate information derived from text.

2. The acquisition of reading strategies coincides and overlaps with the development during childhood of multiple cognitive strategies to enhance attention, memory, communication, and learning.

3. Strategies are controllable by readers; they are personal cognitive tools that can be used selectively and flexibly.

4. Strategic reading reflects metacognition and motivation because readers need to have both the knowledge and disposition to use strategies.

5. Strategies that foster reading and thinking can be taught directly by teachers.

6. Strategic reading can enhance learning throughout the curriculum. (p. 609)

As expected, younger subjects showed a lower level of expertise in reading comprehension; however, when instructed in the use of strategies of reading comprehension used by adult expert readers, the children exhibited significant gains in comprehension (Bereiter & Bird, 1985). Unfortunately, deficits in metacognitive-strategy use in the domain of reading comprehension were also found in the population of college students, who were shown to lack comprehension monitoring and shown to overestimate their use of strategies for increasing comprehension (Brennan, Winograd, Bridge, & Hiebert, 1986; Pressley & Ghatala, 1990; Pressley, Ghatala, Woloshyn, & Pirie, 1990; see review by Baker, 1989).

Metacognitive Strategy Use in Math and Science

Studies of expertise in math and science often compare metacognitive-strategy use by novices and experts (Carey, 1985, 1986; Chi, 1985; Chi & Bassok, 1989; Cobb, 1988; Derry & Kellis, 1986; Gick, 1986; Lampert, 1986; Larkin, 1985; Silver, 1987; Schoenfeld, 1987). Studies of problem solving in math with university students showed that awareness of the need to restructure one's knowledge base (i.e., to fit new information into one's domain-specific knowledge structure); and sensitivity to the type of mental activity that one is involved in (e.g., re-analyzing the problem and monitoring progress vs. pursuing a given strategy) distinguish experts from novices. Similar results were obtained in studies of expert versus novice problem solvers in science (Anderson & Roth, 1989; Carey, 1985, 1986; Vosniadou & Brewer, 1987).

The shift from the concrete, memorized fact to the grey area of abstract, nonintuitive scientific concepts which are not directly related to the student's life experience is problematic to many students (Atwater & Alick, 1990; BauJaoude, 1992; Wong, 1993; Zajchowski & Martin, 1993; Zoller, 1990). Many students enter instruction with faulty conceptual schemes—misconceptions—about the deeper causal relationships between observed phenomena, based on their own observations and interpretations of those observations. Learning science often means conceptual change—that is, replacing existing conceptions and realigning one's knowledge base to accommodate new ideas (Smith, Blakeslee, & Anderson, 1993).

Investigations of difficulties experienced by high school students and college freshmen taking chemistry courses showed that there were three main reasons for these difficulties: (a) The mathematical structure underlying chemical problems (e.g., the mathematical mapping of chemical concept), (b) problem content (e.g., knowledge of chemistry), and (c) mode of presentation (e.g., teaching strategies). The use of the time-honored teaching strategy of concept mapping apparently does not, by itself, guarantee students' understanding (Lambiotte & Dansereau, 1990; Stensvold & Wilson, 1990; Zoller, 1990; but see Cullen, 1990). Other research showed that combining logical strategy instruction with science topic knowledge instruction can be more beneficial to learning than using one instructional approach by itself (Linn, Clement, Pulos, & Sullivan, 1989).

Using a Computer as Lab Partner (CLB), curriculum designed to teach thermodynamics, Linn and her associates (Burbules & Linn, 1991; Eylon & Linn, 1988; Linn, 1987, in press; Linn & Burbules, in press; Linn & Songer, 1991a, 1991b; Linn, Songer, Lewis, & Stern, in press; Songer & Linn, 1991) investigated the effects of computer-aided learning (CAL) of science on facilitating an integrated view of scientific principles (as opposed to a view of science as a collection of static facts to be memorized). They found that "the CLP curriculum helped students integrate scientific principles with everyday experiences and was effective in changing students' stance toward scientific knowledge" (Linn & Songer, 1993, p.68).

Nolen and her associates (Nolen, 1988; Nolen & Haladyna, 1990a, 1990b) investigated the mediating influence of learner variables, such as attitude toward science, motivational orientation, and study strategy beliefs, on the effectiveness of study strategies. They found that "both task orientation and perceived teacher goals appear to influence students' study strategy beliefs which have in turn been shown to be strongly related to use of these strategies" (Nolen & Haladyna, 1990a, p. 200).

The Use of Metacognitive Strategies by Learning-Disabled Students

Results of several recent studies support the belief that students with learning disabilities are deficient in the use of strategies in general and of metacognitive strategies in particular (Bos & Filip, 1982; Bos & van Reusen, 1991; Brozo & Curtis, 1987; Ellis, Deshler, & Schumaker, 1989; Johnston, 1985; Just & Carpenter, 1987; Meltzer, Solomon, Fenton, & Levine 1989; Paris & Oka, 1986a, 1986b; Stife, Weiss, & Bell, 1985; Swanson, 1988a, 1988b; see review by Borkowski, Weyhing, & Turner, 1986). However, the interpretation of this documented deficit is somewhat problematic. Since any consistent behavior—including low academic achievement—requires the use of some kinds of strategy, a deficit of strategies quite obviously cannot be equated with a lack of them. One may then ask, "How are strategies used by LD students different from those used by non-LDs?". Research suggests that LD students who exhibit specific deficits in learning develop strategies that are appropriate for their current skill levels; these levels are, in turn, lower than the expected skill levels when matched by age group and level of intellectual functioning. Consequently, those strategies may be effective in handling their immediate learning goals, but are obviously deficient vis-á-vis higher-level learning goals (Wong, 1985, 1991). An illustration of such a deficit is an LD student decoding and extracting meaning from single words instead of comprehending the read passage (Garner, 1981; Wong & Wong, 1986). Ellis et al. (1989) suggest that when LD students are trained to use specific strategies they do not necessarily learn to verbalize the metacognitive skills involved in the process of generating new strategies. Significant gains in verbalization of metacognitive knowledge are associated with training in use of the executive strategy. In addition, the skill of students with LD in generating new strategies can increase dramatically when training is provided.

The etiology of metacognitive strategies deficit in LD students may be reconstructed following the work of Stanovich (1986, 1988), Butkowsky and Willows (1980), Torgesen (1977), and Wong (1985, 1991). Stanovich (1986) coined the term "Matthews Effect" (in analogy to the biblical story of the poor getting poorer and the rich getting richer) to describe the dynamics of the widening gap, over time, between poor and good readers. Early and persistent failure in learning to read results in motivational problems (Torgesen) that later generalize into other academic areas (Butkowsky & Willows). Similarly, the gap between, on the one hand, gifted students who possess extensive repertoires of strategies (Jausovec, 1991) , on the other, LD students who are deficient in spontaneously generating efficient strategies also widen over time (Wong, 1985, 1991).

Training in Metacognitive Strategy Use

The possibility of intervention and training in the use of metacognitive strategies has recently attracted the attention of researchers (Borkowski, Estrada, Milstead, & Hale, 1989; Cramond, Martin, & Shaw, 1990; Cross & Paris, 1988; Hollingsworth & Woodward, 1993; Jacobs & Paris, 1987; Malloy, Mitchell, & Gordon 1987; McKeachie, Pintrich, & Lin, 1985; Paris & Oka, 1986a; Swanson, 1990a; see review by Derry & Murphy, 1986).

Several studies reported that instruction in self-monitoring resulted in increased on-task behavior of LD students (e.g., Blick & Test, 1987; DiGangi, Maag, & Rutherford, 1991; Hallahan, Lloyd, Kneedler, & Marshall, 1982; Prater, Joy, Chilman, Temple, & Miller, 1991; see review by Hallahan & Sapona, 1983). Other studies reported that providing elaborate feedback during the instructional process increased retention and improved scores of LD students (Bloom, 1984; Walberg, 1984; Kline, Schumaker, & Deshler, 1991).

Cramond, Martin, and Shaw (1990) studied the generalizability of creative problem procedures to real-life situations and developed a training program called *Creative Problem Solving* (CPS), which is meant to teach people to approach and solve problems more effectively. Borkowski and his associates (Borkowski, Johnson, & Reid, 1987; Borkowski, Milstead, & Hale, 1988; Borkowski, Estrada, Milstead, & Hale, 1989; Groteluschen, Borkowski, & Hale, 1990; Reid & Borkowski, 1987) presented a model of metacognition with four major parts: (a) Specific strategy knowledge (e.g., as pertaining to specific problem-solving situations), (b) relational strategy knowledge, (c) general strategy knowledge including associated attributional beliefs about self-efficacy, and (d) metacognitive acquisition procedures. Borkowski and his associates proposed a novel "double barrel" approach to the training of LD students in the use of metacognitive strategies that combines re-attribution training with training in executive processes of self-regulation.

They emphasize that an objective analysis of failed performance is the key to depersonalizing failure and thus building academic self-efficacy and self-esteem; it must, however, be supported by direct instruction aimed at increasing self-regulation through the practice of metacognitive strategies.

Assessment of Metacognition

One of the few behavioral measures of a metacognitive strategy is *post-failure reflectivity*, defined as the tendency to reflect longer on failure feedback than on success feedback (Shafrir, Siegel, & Chee, 1990; Shafrir & Eagle, in press; Shafrir, Ogilvie, & Bryson, 1990; Shafrir & Pascual-Leone, 1990). Informative feedback is an important element in cognitive training (Phye, 1991; Phye & Sanders, 1992; Steinberg, Baskin, & Hofer, 1986), and post-failure reflectivity is clearly a metacognitive strategy that is applicable across tasks and across domains. A post-failure reflective subject may contemplate negative feedback on learning and problem-solving tasks in content domains as disparate as reading, writing, arithmetic, and visual problem solving—to mention only a few. Indeed, Shafrir and his associates have shown that post-failure reflective subjects (in contrast to *post-failure impulsive* subjects) are good learners who score higher on a great variety of tests of intellectual functioning and academic achievement. They also showed and that post-failure reflectivity is a reliable and valid measure that generalizes across domains.

Another assessment tool designed specifically for the diagnostics of metacognition is the Index of Reading Awareness [IRA] (Jacobs & Paris, 1987).

Perceived Competence

Performance on a cognitive task has traditionally been assumed to be determined by the individual's cognitive ability. Davidson and Sternberg (1985) defined the difference between competence and performance thus:

> By competence, we refer to the availability of skills and logical structures such as information processes, knowledge, functional capacity of working memory, and representational formats in which information can be stored. By performance, we refer to the utilization of competence, as mediated by the accessibility in a given task and situation of factors including processes, knowledge, working memory, representations, motivation, cognitive styles, and external resources (p. 44).

This approach is the bedrock upon which virtually all current assessments of competence are based—that is, demonstration of mastery in the application of rules that are, for the most part, memorized and often decontextualized.

Recent research has shown that, even when differences in cognitive ability are statistically controlled, there remain large individual differences in performance on cognitive tasks between individuals of similar ability (Bandura & Wood, 1989; M. Bandura & Dweck, 1988; Collins, 1982; Elliott & Dweck, 1988; Wood & Bandura, 1989). What are the sources of such differences? Theorists have long believed that perceptions of the self play a role in motivating and organizing behavior (Allport, 1955; Beck, 1967; Rogers, 1961). Bandura's social learning theory (Bandura, 1977; 1986; 1990) suggests that cognitive ability, (i.e., possession of a cognitive skill and knowledge how to apply it) is indeed a necessary condition for the production of a successful performance but often not sufficient one. Successful performance is mediated by additional mechanisms related to the individual's perception of the situation that evokes the performance. These mechanisms include the person's construal of the external situation, as well as interpretation of the degree of his/her ability to respond successfully to that situation (Ross & Nisbet, 1991). Important (but different) roles are played by: (a) Motivational processes (e.g., perseverance in the face of difficulties to attain a goal; Bandura, 1988a; Bandura & Cervone, 1983, 1986; Cervone & Peake, 1986; Weinberg, Gould, & Jackson, 1979), (b) affective processes (e.g., emotional reactions of stress, anxiety, and depression in response to threatening or taxing situations; Bandura, 1988b; Kent, 1987; Kent & Gibbons, 1987; Lazarus & Folkman, 1984; Salkovskis & Harrison, 1984; Sarason, 1975), and (c) selection processes (e.g., selection of a path of personal development in response to social influences; Bandura, 1986; Betz & Hackett, 1986; Lent & Hackett, 1987; Snyder, 1987).

Central to Bandura's theory of social learning (Bandura, 1977, 1986) is the construct of *self-efficacy*—the person's beliefs in his capability to exercise control over external challenges that affect his life, to organize and execute plans of action, and to achieve desired changes.[2] According to Bandura (1977, 1986), personal beliefs of efficacy are informed by the following: (a) accomplishments of past performance (e.g., mastery experience raises, and failure experience diminishes, self-efficacy), (b) vicarious experience (e.g., observing, comparing, and modeling successful behaviors of others), (c) verbal persuasion (Bandura views this effect as weak and of limited potential), and (d) emotional arousal. (For example, individuals often rely on their physiological state for signals that they then use to guide their behavior; threatening or stressful situations act to lower self-efficacy, but euphoric emotions enhance self-efficacy.)

The construct of self-efficacy is also related to the interpretation of the social world, which is a topic of great concern to social psychologists. Briefly, at issue is the way in which a person interprets a situation prior to making a decision regarding a possible response. Many studies have shown that the interpretation is often critically dependent on the subjective reading of the situation (e.g., the person's interpretation of the relevance of variables and of relationships among salient features of the situation; Kahneman & Miller, 1986; Kahneman & Tversky, 1979; Strack, Martin, & Schwarz, 1988; Taylor, 1983; Tesser, 1980). Indeed, a recent influential treatise on social psychology has labeled self-efficacy as an *attributional* style (Ross & Nisbett, 1991).

Behavior is mediated by symbolic representations of expected outcomes (Bandura & Cervone, 1983), and self-efficacy plays a major role in people's involvements in real-life situations if the task at hand presents sufficient incentives (e.g., clear and important outcomes) and if the person possess the requisite component skills. Bandura and his associates conducted many studies and reported results that supported the hypothesis of causal relationship between self-efficacy and behavioral change (Bandura, Adams, & Beyer, 1977; Bandura, Reese, & Adams, 1982; see review by Grusec, 1992).

Self-efficacy can be instrumental in determining learning outcomes since it provides educators with access to processes that may result in enhanced academic performance. This is because judgments of self-efficacy are not merely reflections of past performance, but are malleable and open to direct influence of environmental variables that can be mediated by educators. Among factors that were shown to enhance academic success in mathematics and in reading comprehension through increased self-efficacy are the setting of proximal skill acquisition and learning goals (Bandura & Schunk, 1981), comparative feedback on peer performance and attributional feedback (Schunk, 1984b; Schunk & Rice, 1986), and peer modeling of successful performance (Schunk, Hanson, & Cox, 1987).

Several studies related enhanced self-efficacy to self-talk in the context of strategy instruction (e.g., verbal conceptualization of self/talk interaction is an important guide in the acquisition of mastery; Borkowski, Carr, Rellinger, & Pressley, 1990; Borkowski, Estrada, Milstead, & Hale, 1989; Diener & Dweck, 1978, 1980; Harris & Pressley, 1991; Schunk, 1984b; Swanson, 1990b).

Assessment of Perceived Competence

The assessment of perceived competence was a topic of interest to psychologists and educators since the early 1950s. Studies of perceived competence of college students examined the following aspects of self-estimates: (a) accuracy (e.g., college students were found to be fairly accurate in estimating their abilities; Biggs & Tinsley, 1970; Doleys & Renzaglia, 1963; Goldman, Flake, & Matheson, 1990; Morrison, Thomas, & Weaver, 1973; Young, 1954); (b) group characteristics (e.g., realistic estimators were found to have both higher estimates and higher ability than under- and over-estimators; Bailey & Shaw, 1971; Kirk & Sereda, 1969); (c) developmental differences (e.g., more mature students were more accurate in their self-estimates than younger ones; Harter, 1985; Wolfe, 1972); (d) gender differences (e.g., males rated themselves higher than females, and males showed greater overestimations than females; Goldman, Flake, & Matheson, 1990; Kistner, Haskett, White, & Robbins, 1987; Swanson & Lease, 1990); and (e) personality factors (e.g., motivation, adjustment, emotional dysfunction, and self/ideal-self discrepancy are related to self-estimates; Bailey & Lazar, 1976; Bailey & Shaw, 1971; Morrison, Thomas, & Weaver, 1973; Petzel, 1972).

Mabe and West (1982) reviewed 55 studies of self-evaluations of ability and questioned the validity of the results of many of these studies based on their critical analysis of the assessment procedures used. They concluded that measures of self-estimates should conform to nine criteria in order to be considered valid. The most important criteria were: (a) Measures of self-evaluation must match normally assessed ability measures and subjects must expect validation of the self-estimates with actual results, (b) relative (not absolute) judgments should be sought, and a social referent group must be clearly defined; (c) subjects must have experience in making evaluations, and (d) anonymity must be guaranteed.

Perceived Competence in Learning-Disabled Students

Research has shown that subjects with low self-esteem are more likely than those with high self-esteem to give up on the task at hand in the face of negative feedback (Brockner, Derr, & Lairg, 1987). This finding is undoubtedly relevant to students with learning disabilities, who were shown to have low self-esteem compared to their peers (Bryan, 1991; Chapman & Lambourne, 1990; Heyman, 1990; Kistner & Osborne, 1987; Kistner, Osborne, & LeVerrier, 1988; La Greca & Stone, 1990; Pearl & Bryan, 1982; Rosenberg, & Gaier, 1977; Saracoglu, Minden, & Wilchesky, 1989; Winne, Woodlands, & Wong, 1982). Students with learning disabilities also have problems in three closely related areas, namely self-perception of their own learning disability (Heyman, 1990), and intrinsic motivation, and causal attribution of success and failure (Adelman, 1978; Aponik & Dembo, 1983; Knowles, 1983). In a study of college students, Houck, Engelhard, and Geller (1989) found that students with LD perceived themselves as having significantly more problems than students without LD in reading, writing, visual information processing, and short-term memory.

Several researchers presented models which proposed the enhancement of academic performance in students with learning disabilities through intervention aimed at increasing their perceived competence (Borkowski, Day, Saenz, Dietmeyer, Estrada, & Groteluschen 1992; Heyman, 1990; Schunk, 1989a, 1989b; Vogel & Adelman, 1990).

Conclusions

The above review of recent research shows that our understanding of important psychological processes that underlie the ability to learn has improved considerably over the past decade or so. Specifically, the broad picture emerging from many studies is one that shows the potential for new assessment and remediation procedures aimed at improving study skills in adolescents and adults. This approach served as the theoretical underpinning for the development of an assessment battery that combines new, standardized procedures, with well-established, normed tests, and a corresponding battery of instructional methodologies for the remediation of specific study skills. Both the assessment and the remediation batteries have been developed and field-tested at the Adult Study Skills Clinic at the Ontario Institute for Studies in Education (Shafrir, 1995a, 1995b). These batteries were also implemented several years ago at the Learning Disabilities Program at the University of Toronto, and are now being adapted by various post-secondary institutions and private-sector companies. The adaptation and implementation of these batteries may benefit adolescents and adults in literacy programs in the United States. The following section is a brief review of the new methodologies.

A New Remediation-Based Approach to the Assessment of Study-Skill Deficits in Adolescents and Adults

Study skills, like other skills, develop over a person's lifetime and are one manifestation of that person's individual path of cognitive and affective development. Study skills are hierarchical in nature: there are high-level and low-level study skills. Higher-level study skills such as reading, writing, memorizing, and problem-solving, which are essential for the acquisition and maintenance of literacy skills, evolve within the individual over time in a process of developmental scaffolding and the integration of well-practiced lower-level skills. The lack of a specific higher-level skill is often a symptom of a deficit in lower-level skills. For instance, in the area of reading, comprehension is a high-level skill whose development depends on competence in lower level skills such as single-word decoding, knowledge of grammatical rules, and so on.

An optimal design of an assessment battery should be aimed at identifying the level of internal discontinuity in skill development, (i.e., the point in the hierarchy where the existence of specific deficient lower-level skills held back the development of the high-level skill in question). This optimal design can be achieved through a top-down assessment procedure that includes both a specific initial assessment of a high-level skill, where the results point to specific aspects of sub-optimal performance (rather than to a global measure of performance (see section on writing assessment below) and an optional follow-up assessment of the specific lower-level skills that were implicated as defective in the previous step.

Such a design offers the following important advantages:

1. *Optimal use of resources.* An initial group-administered assessment of high-level skills in reading, writing and arithmetic, identifies those students with deficits in these areas. A more detailed, individually-administered follow-up assessment is then administered to those students with identified severe deficits.

2. *Remediation-based assessment.* The results of these assessments are then used as direct clues for the design of group- or individually-administered remediation programs.

In contrast to the traditional deficit model of cognitive abilities that has focused on specific information processing deficits, the present approach is multifaceted and includes additional components that assess both the cognitive and affective strengths and weaknesses of the student in such areas as encoding and processing of specific types of information, modality preferences, learning style, self-efficacy, motivation, interpersonal and social skills, emotions and relationships, and familial/peer support.

The new approach is based on an initial *dynamic assessment of processes* rather than products (e.g., behavioral measures and self-reports designed to capture process variables and strategy choices) and on a follow-up application of *instructional-based assessment in a mediated learning environment*, where the instructor plays the role of mediator (e.g., by providing carefully timed cues that facilitate the expansion and consolidation of the student's repertoire of study skills). The extensive use of computers as the underlying technology in this new approach to assessment facilitates the unobtrusive and continuous monitoring of the student's performance and provides access to process variables and measures that were hitherto unavailable (e.g., the student's estimate of the level of difficulty of the task at hand, and the student's attention to feedback regarding his or her own errors).

The new approach recognizes the fact that the person being assessed is a mature and intelligent individual, who can elaborate strategy choices and is often capable of providing deep insights into the specific nature of his or her study-skills deficits. The person is treated as a full partner in the interpretation of assessment results and in planning the remediation program.

Finally, the new approach includes a reporting procedure where test results are automatically processed by the computer and presented in a format that facilitates their interpretation. Results are reported in terms of (a) the number of standard deviations above or below the means for specific populations (e.g., by type of institution, program areas, etc.); and (b) self-reports of the strategies that the person used in the various tests that provide direct clues for the design of an individual program of remediation.

Endnotes

[1] It is a widely held belief in the research community that dyslexia is causally related to neurological dysfunction which may be reflected in the brain's anatomical structure (Galaburda, 1991; Hynd, Marshall, & Gonzalez, 1991; Steinmetz & Galaburda, 1991). This may justify adding the adjective "structural" to a diagnosed LD condition in adults, as opposed to a label of functional LD for adults with deficient literacy skills. Unlike illiteracy, learning disability seems to be a "womb to tomb" condition.

[2] It is important to note that self-efficacy differs from other similar-sounding, self-referrential constructs such as self-concept (e.g., the construal of oneself through self-evaluations derived from interactions in a social environment and from self-attributions; Byrne & Shavelson, 1986; Coopersmith, 1967; Damon & Hart, 1982; Harter, 1983, 1988; Rosenberg, 1985), self-worth (e.g., the value that one places upon oneself as an actor in specific content areas; Harter, 1986b, 1987), and self-esteem (e.g., the degree of feeling good about oneself—defined as global self-worth by Harter, 1990).

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