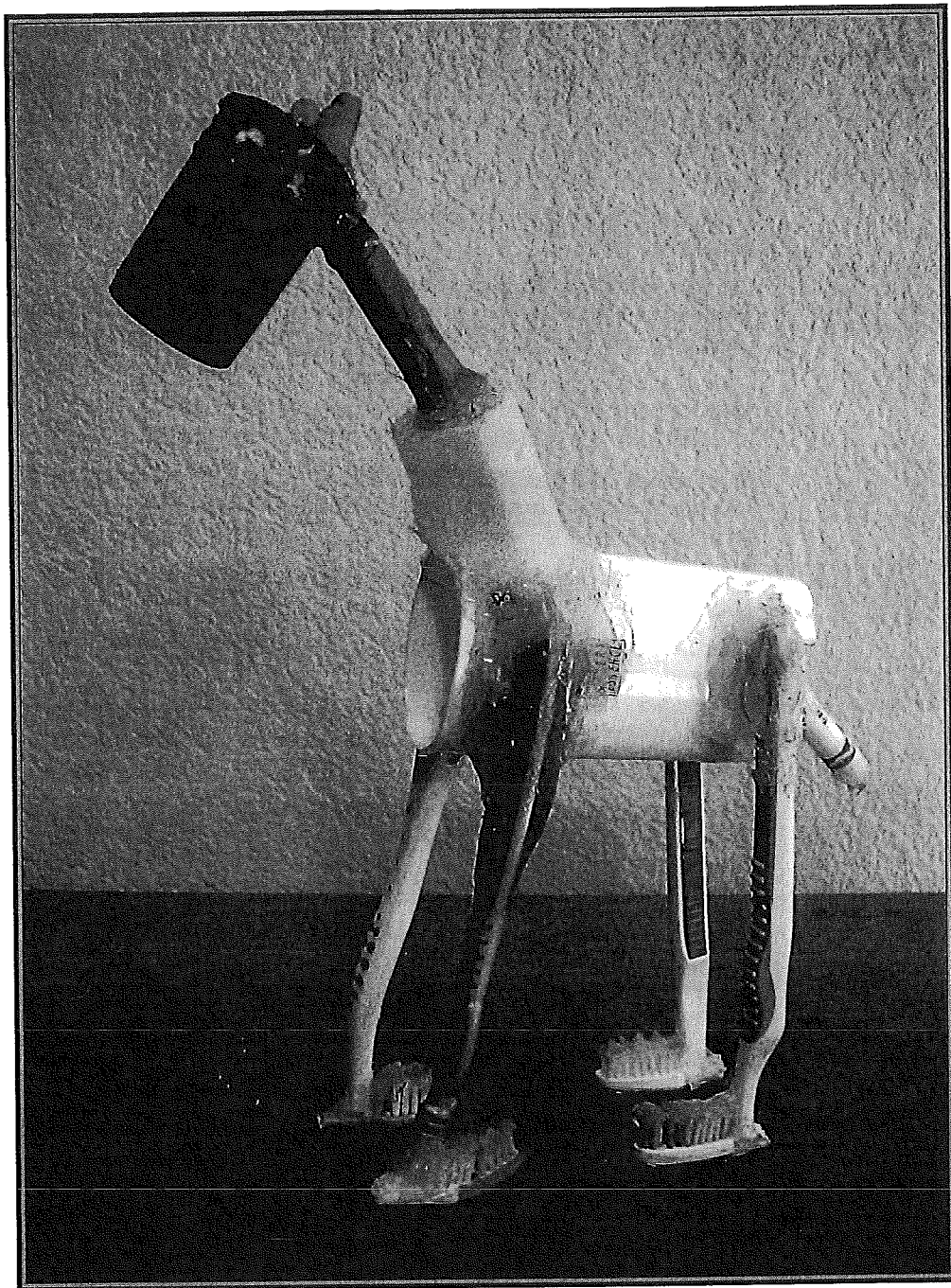


Journal of Learning Disabilities[®]



SEPTEMBER/OCTOBER 2007

VOLUME 40, NUMBER 5

PAGES 385-480

Journal of Learning Disabilities

Volume 40, Number 5, September/October 2007



Publisher: Donald D. Hammill
Periodicals Director: Peggy Kipping
Managing Editor, Production: Lisa Tippett
Sr. Production Editors: Melissa McGee Tullos,
Melissa Hilton
Jr. Production Editor: Max Romero
Production Assistants: Jenifer Welch (editorial),
Eric Pendley (design)
Advertising: Lee Ann Mendoza
Circulation Manager: Pete Serrano

The *Journal of Learning Disabilities* (ISSN: 0022-2194) (USPS 867-200) is published bimonthly by the Hammill Institute on Disabilities, 8700 Shoal Creek Blvd., Austin, TX 78757-6897. Periodicals Postage Paid at Austin, Texas, and additional mailing offices.

POSTMASTER: Send address changes to *Journal of Learning Disabilities*, 8700 Shoal Creek Boulevard, Austin, TX 78757.

Subscription Rates: Combined Individual Rate (print and electronic) \$69; and Combined Institutional Rate \$209. Electronic only and print only subscriptions are available for institutions at a discounted rate. Single issue rates are \$18 for individuals and \$38 for institutions.

Business Correspondence: Subscription inquiries, subscription orders, change of address, and so forth should be addressed to the Hammill Institute on Disabilities, 8700 Shoal Creek Boulevard, Austin, TX 78757-6897; 512/451-3521; fax: 512/451-3278 (allow six weeks for address change).

Advertising: Direct inquiries and correspondence to Journal Advertising Sales, the Hammill Institute on Disabilities, 8700 Shoal Creek Boulevard, Austin, TX 78757-6897.

Author Guidelines are available at:
<https://mc.manuscriptcentral.com/jld>

Rights and Permissions: © 2007 the Hammill Institute on Disabilities. Printed in U.S.A. All rights reserved. No part of this publication may be reprinted or reproduced in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system without permission in writing from the publisher. Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by the Hammill Institute on Disabilities, provided that the base fee of U.S. \$0.00 per copy, plus U.S. \$0.05 per page is paid directly to Copyright Clearance Center, 222 Rosewood Dr., Danvers, MA 01923, USA. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is: [0022-2194/07 \$0.00 + \$0.05].

Journal of Learning Disabilities is abstracted/indexed in the following: Academic Abstracts FullTEXT; Applied Social Sciences Index & Abstracts; Bibliographic Index; Book Review Index; Contents Pages in Education; Cumulative Index to Nursing and Allied Health Literature; Current Contents: Social & Behavioral Sciences; Education Resources Information Center; Educational Administration Abstracts; Educational Research Abstracts Online; Excerpta Medica; Expanded Academic ASAP; Health and Psychosocial Instruments; Higher Education Abstracts; International Bibliography of Book Reviews of Scholarly Literature in the Humanities and Social Sciences; International Bibliography of Periodical Literature in the Humanities and Social Sciences; Linguistics and Language Behavior Abstracts; Mediafinder; MEDLINE; MLA International Bibliography; PAIS International; Physiotherapy Evidence Database; PsycINFO; PubMed; REHABDATA; Research Alert; Social Sciences Citation Index; Sociological Abstracts; Special Educational Needs Abstracts; Wilson Education Abstracts; Wilson Education Index. FULL-TEXT VERSIONS are available in electronic form from EBSCO, Allied and Complimentary Medicine Database, eLibrary, Ingenta, Clinical Abstracts to Reading and Learning Disabilities, ClinPSYC, ProQuest Information and Learning, Wilson Education Full Text, Wilson OmniFile Full Text Mega Edition. Full-text microform versions are available from National Archive Publishing Company.

SPECIAL SERIES: AUSTRALIAN RESEARCH IN LEARNING DISABILITIES

Lorraine Graham and Jeff Bailey, Guest Editors

Learning Disabilities and Difficulties: An Australian Conspectus—Introduction to the Special Series 386

Lorraine Graham and Jeff Bailey

Learning Disabilities: Bringing Fields and Nations Together 392

John Elkins

Language Delays, Reading Delays, and Learning Difficulties: Interactive Elements Requiring Multidimensional Programming 400

Ian Hay, Gordon Elias, Ruth Fielding-Barnsley, Ross Homel, and Kate Freiberg

QuickSmart: A Basic Academic Skills Intervention for Middle School Students with Learning Difficulties 410

Lorraine Graham, Anne Bellert, Jenny Thomas, and John Pegg

Developing Mathematical Proficiency in the Australian Context: Implications for Students With Learning Difficulties 420

David Evans

Teachers' In-Flight Thinking in Inclusive Classrooms 427

David Paterson

Learning Disabilities in Australian Universities: Hidden, Ignored, and Unwelcome 436

Janette Ryan

REGULAR ARTICLES

Innovative Programs for Improvement in Reading Through Cognitive Enhancement: A Remediation Study of Canadian First Nations Children 443

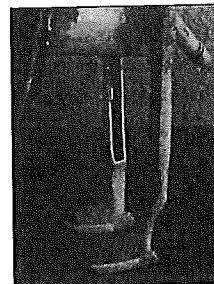
Denyse Hayward, J. P. Das, and Troy Janzen

Cognitive Characteristics of Children With Mathematics Learning Disability (MLD) Vary as a Function of the Cutoff Criterion Used to Define MLD 458

Melissa M. Murphy, Michèle M. M. Mazzocco, Laurie B. Harnich, and Martha C. Early

Calendar 480
Editorial Policy inside back cover

About the Artist: According to his family, William Wright, 14, has always been excellent at three-dimensional problem solving. Will's sculpture, "Horse," created from plastic recyclables and a hot-glue gun, shows off this skill admirably. Will has brought such items as toothbrushes, empty film containers, and a disposable shaver handle to life. As a gifted rider, Will chose his subject matter because horses have such a big, positive place in his life. "Horses bring calm, accomplishment, and love," he explains. Mr. Danenberg, Will's eighth-grade art teacher at Summit View School, encourages students to "personally connect" with their art projects. Summit View, an innovative non-public school created by The Help Group, is located in Valley Glen, California, and serves children with learning differences from 2nd through 12th grade.



QuickSmart:

A Basic Academic Skills Intervention for Middle School Students with Learning Difficulties

Lorraine Graham, Anne Bellert, Jenny Thomas, and John Pegg

Abstract

QuickSmart is a basic academic skills intervention designed for persistently low-achieving students in the middle years of schooling that aims to improve the automaticity of basic skills to improve higher-order processes, such as problem solving and comprehension, as measured on standardized tests. The *QuickSmart* instructional program consists of three structured, teacher- or teacher aide-directed, 30-minute, small-group lessons each week for approximately 26 weeks. In this study, 42 middle school students experiencing learning difficulties (LD) completed the *QuickSmart* reading program, and a further 42 students with LD took part in the *QuickSmart* mathematics program. To investigate the effects of the intervention, comparisons were made between the reading and mathematics progress of the intervention group and a group of 10 high-achieving and 10 average-achieving peers. The results indicated that although the standardized reading comprehension and mathematics scores of *QuickSmart* students remained below those of comparison students, they improved significantly from pretest to posttest. In contrast, the standardized scores of comparison students were not significantly different from pretest to posttest. On measures of response speed and accuracy gathered using the *Cognitive Aptitude Assessment System* (CAAS), *QuickSmart* students were able to narrow the gap between their performance and that of their high- and average-achieving peers. Implications are drawn regarding the importance of interventions that emphasize the automaticity of basic academic skills for students with learning difficulties.

Students with learning difficulties (LD) in the middle school years typically display slow and effortful performance of basic academic skills in both reading and mathematics. This lack of facility in reading and calculating reflects inefficiencies in cognitive processes that have far-reaching implications across learning, teaching, and affective domains. This article examines difficulties in students' basic academic skills from a cognitive perspective and describes the *QuickSmart* program, a responsive small-group intervention that aims to develop fluent (*Quick*) and efficient (*Smart*) strategy use. *QuickSmart* uses research-based instructional strategies to support the learning of persistently low-achieving middle school students so that they are more actively and suc-

cessfully engaged in inclusive classroom settings.

In terms of developing proficiency with basic academic skills, most students with LD during their middle school years make only small gains in learning and classroom performance. Effectively, the "gap" between their achievement levels and those of their peers without LD widens year after year (Cawley, Fan Yan, & Miller, 1996; Hempenstall, 2005; Swanson & Hoskyn, 2001). In the Australian context, where students with LD do not routinely attract individual funding or intensive aide support, teachers are increasingly required to make adjustments to their classroom instruction to accommodate students with particular learning needs. Because of the pressures in inclusive classrooms, these

modifications tend to be "on the spot" and do not always provide the intensity and duration of instruction needed to address persistent learning difficulties. Although the intent of inclusion is undeniably positive, it is questionable whether classroom teachers always have the time and strategic resources necessary to meet the complex learning needs of students experiencing LD. At this time, all educators and education systems are searching for cost-effective ways to address students' learning challenges through adjustments to classroom instruction and through a range of support models.

The need for effective interventions to support middle school students with LD is clear. These students are an underserved group relative to younger students with LD in terms of

resources, the availability of validated interventions, and effective, research-based teaching practices. This situation has long-term effects in terms of the future prospects of individuals with LD (Bellert & Graham, 2006; Deschler, 2005; Rowe, 2006). Although older students with LD in reading can find it difficult to access appropriate support, students with LD in mathematics are doubly disadvantaged because of the dearth of research-based intervention programs and validated strategies for older students with LD in mathematics (Louden et al., 2000).

The *QuickSmart* intervention and research program attempts to fill some of the identified gaps in research and practice regarding middle school students with persistent learning difficulties. Specifically, *QuickSmart* aims to provide an intense intervention focused on basic academics that can equip students with the skills necessary to engage more successfully with classroom instruction. The *QuickSmart* intervention was designed as a relatively long-term, yet cost-effective, program for students in middle school who perform low on basic reading and mathematics skills. The theoretical orientation of the intervention is an information-processing view of cognitive operations, informed by a perspective largely consistent with modularity theory (see Fodor, 1985; Perfetti, 1988, 1992; Stanovich, 1990).

Research Orientation

The research that informs *QuickSmart* is focused particularly on cognitive processing, the conditions necessary for gaining facility with lower order tasks or basic academic skills, and the potential complementary effects of improved mastery of these skills on higher order learning processes. Accordingly, this study has two goals: to investigate improved fluency with basic academic skills and to observe whether improved fluency with the basics has any effect on the performance of more demanding academic tasks, such as comprehension and mathematical problem solving, as re-

flected in students' performance on standardized achievement tests. The design of the intervention itself draws on understandings about the nature of LD experienced by older children and adolescents and on current knowledge concerning the obstacles to efficient cognition that students with LD commonly experience.

Furthermore, "self-factors" such as student self-efficacy, self-confidence, and scaffolded risk taking are an important part of the *QuickSmart* research framework. Although these affective factors are not the focus of the research reported in this article, their importance in underpinning improved learning outcomes for students experiencing LD is acknowledged.

Learning Difficulties in Middle School

Difficulties in reading are the most widespread learning problems experienced by students with LD (Westwood & Graham, 2000). Contemporary theories of reading difficulties commonly acknowledge weaknesses in phonological processing, orthography, and naming speed as key processing deficits (Siegel, 2003; Wolf & Bowers, 1999). Students' lack of proficiency in these basic skills negatively affects their higher level comprehension processes.

The most obvious problem displayed by students with LD in reading is a serious deficit in swift and accurate word identification (Burns, Griffin, & Snow, 1999; Torgesen, 2000). Many middle school students with LD can comprehend spoken language at or close to their age-appropriate levels, yet their low reading skills deny them similar access to written texts (Graham, 1993; Spring & French, 1990). Students with reading difficulties commonly need to use their cognitive resources of time and attention to decode words and process text, at the expense of limiting attention-demanding, higher order thinking and learning, such as comprehension and problem solving (Walczyk, 2000). Obviously,

this limited ability to decode fluently and to make sense of texts affects students' levels of performance and their participation in content-area learning.

Students with LD in reading also experience problems with reading comprehension, which can be attributable to factors such as poor decoding, the use of inefficient strategies, and poor knowledge about texts and text structure (Graham & Bellert, 2005). Besides these difficulties, a lack of background knowledge can lead to a limited level of engagement with text that becomes exacerbated over the years. This further explains why poor readers increasingly fall behind their peers as they progress through school.

Similarly, students experiencing LD in mathematics struggle in areas such as basic computation skills, word problems, understanding the language of mathematics, and mathematical reasoning (Milton, 2000). They experience failure for a variety of reasons, including poorly developed number sense, poor processing abilities, language and literacy difficulties, mathematics anxiety, and inefficient memory processes (Vaughn, Gersten, & Chard, 2000). More important, researchers have also concluded that the reasons for students' failure in mathematics (and reading) can be directly related to teaching methods and curriculum issues, rather than being attributable only to factors that reside within the learner (Pincott, 2004; Vaughn, Bos, & Schumm, 1997).

With regard to the area of mathematical computation, students with LD often display inaccurate or inefficient strategies, poor and error-prone retrieval of previously encountered content, and reduced or variable speeds of processing basic number facts (Chan & Dally, 2001). In fact, Geary's (2004) research has suggested that disruptions in the ability to retrieve basic math facts from long-term memory can be considered a defining feature of mathematical learning disabilities. Just as slow and laborious decoding of words uses up cognitive resources and impedes the comprehension of text, the effortful calculation of basic arith-

metic facts can preclude students with LD from focusing on mathematical procedures and problem solving. As a result, content-area learning in mathematics and applied problem solving can be much less accessible for students with LD.

In addition to deficits in basic academic skills, many students with LD in the middle years of schooling also have particular cognitive characteristics that impede their learning, such as reduced working memory capacity and the use of ineffective procedures for managing the components of working memory. Students with LD, in general, tend to be inefficient in their approaches to learning (Westwood, 1993). Such inefficiencies include using inappropriate strategies that produce high error rates. Students with LD can experience difficulty recalling previously encountered knowledge and may not link accumulated information effectively (Doyle, 1983; Westwood, 1993). Thus, students with LD often use lower level, inefficient strategies, such as counting on their fingers to work out number facts or always using "sounding out" to decode previously encountered words. They frequently develop inefficient cognitive habits and less effective strategic ways of thinking and tend not to be automatic with basic academic skills.

Teachers can readily observe students with LD being "slowed down" by their lack of automaticity with lower order academic skills. Automaticity is inferred when processes become fast, routine, and independent and require only small amounts of cognitive resources (Wolf, 1991). Automaticity develops with solid knowledge of the relevant content and through practice (Bellert & Graham, 2006). Once students have sound conceptual understandings, developing automaticity in basic academic skills can enable students with LD to use their working memory resources more efficiently, so that they are better able to engage with the more interesting aspects of learning—the novel concepts,

complex content, and rich tasks that usually require higher order thinking and learning skills.

Automaticity has also been characterized as a process of accessing and using knowledge stored in long-term memory. La Berge and Samuels' (1974) influential article focused on the role and processes of automaticity in information processing. Their model of automaticity in reading proposed that specific word identification patterns, or component skills, become automated in a hierarchical sequence. The implication of this proposition is that students need to develop automaticity in lower order academic skills before they can develop fluency in higher order cognitive operations.

Wolf, Miller, and Donnelly (2000) provided a contemporary definition of automaticity when they described it as a continuum on which processes are considered automatic if they are fast, obligatory, and autonomous and require only limited use of cognitive resources. Accordingly, automaticity is a process that is defined succinctly as the efficient use of available cognitive resources. Other characteristics of automaticity identified in the literature include its being unstoppable or mandatory in nature (Anderson, 1981; Shiffrin & Schneider, 1977) and its being a process that does not reduce the learner's capacity for performing other tasks simultaneously (Shiffrin & Dumais, 1981). Thus, automaticity of basic academic skills enables students to do more than one thing at a time—for example, decoding text and processing meaning, or calculating a sum while using a problem-solving strategy.

Lack of automaticity in the component skills of academic learning becomes increasingly problematic for students with LD in the middle school years because at this stage of schooling, many component skills are required to readily access the curriculum. By this time, however, many students with LD are visibly "slowed down" by their lack of automaticity and are less able to focus on higher order skills or proce-

dural requirements because the sub-skills of decoding and calculating are so effortful. If automatic processing frees up capacity and resources within working memory, enabling higher order or novel aspects of a task to be processed (Thompson & Nicholson, 1999), then automaticity in component skills seems to be fundamental to addressing the needs of students with LD.

The lack of automaticity in basic academic skills demonstrated by many students with LD can be seen as a disadvantage that has multiple consequences: Not only do these students need to work harder than their peers without LD but the focus of their attention often remains on the lower order aspects of tasks. This can prevent them from engaging with the curriculum and is an illustration of how a lack of automaticity in basic academic skills impairs students' participation in learning and their acquisition of new knowledge.

Research Focus

As already stated, the *QuickSmart* research program attempts to fill some of the identified gaps in research and practice for middle school students with learning difficulties. Accordingly, this study has two goals: (a) to investigate the effectiveness of an intervention designed to improve students' fluency with basic academic skills, and (b) to observe the effect of improved fluency with the basics on students' performance on more demanding academic tasks, such as their performance on standardized achievement tests.

Method

The *QuickSmart* program aims to narrow the gap between the learning achievements of the targeted *QuickSmart* students and their high- and average-achieving peers. This article focuses on the results of the intervention in three participating schools in the New England region of New South Wales, Australia.

Student Selection for the QuickSmart Program

A total of 84 students enrolled in middle school grades (Grades 5, 6, and 7) across three schools in a large rural town in New South Wales were selected to participate in either a reading or a mathematics *QuickSmart* intervention. Forty-two students (18 girls and 24 boys) were involved in the reading program, and 42 students (22 girls and 20 boys) completed the mathematics program. The average age of participating students was 11 years 7 months. Eleven students identified as Indigenous Australians.

Students were selected to participate based on their statewide testing results, low scores on preintervention individual standardized tests (the Australian-normed *Progressive Achievement Tests*; Australian Council for Educational Research, 2001), and nomination by their class teachers as students experiencing persistent learning difficulties. Some of these students had participated in but not benefited from previous interventions. In general, the students selected demonstrated a lack of confidence and progress in basic reading or mathematics.

Comparison Student Selection

Twenty high- and average-achieving students were selected from the same schools to provide comparison group data. Ten of these students (5 average and 5 high achieving) provided comparative data for the reading intervention, and 10 students (5 average and 5 high achieving) provided a comparison for the mathematics intervention group. The decision was made on ethical grounds to include as many students experiencing learning difficulties who qualified for the intervention as possible, instead of randomly assigning students to intervention and control groups. Thus, a comparison group of high- and average-achieving students who received classroom instruction was selected to provide a bench-

mark in terms of response speed and accuracy on cognitive assessments and to explore students' skill improvement on standardized test scores.

Pretest and Posttest Assessments

Preintervention and postintervention testing of both the selected *QuickSmart* students and the comparison students was completed using the standardized *Progressive Achievement Tests* (PAT; Australian Council for Educational Research, 2001) for mathematics and comprehension, as well as a bank of reading or mathematics tasks from the *Cognitive Aptitude Assessment System* (CAAS) computer assessment package (Royer, 1996; Royer & Tronsky, 1998).

The CAAS system provides measures of how rapidly students complete tasks by speaking into a microphone once a word, a cloze sentence, or a number fact appears on the computer screen. An instructor scores each response for accuracy. Students' assessment results are automatically averaged per item and made available in either a graph or report form that is easily interpretable by both students and teachers. The CAAS is a unique component of the *QuickSmart* program. It provides ongoing monitoring of students' basic academic skills during lessons and supports the instructional focus of the *QuickSmart* intervention when used for data collection at pretest and posttest.

QuickSmart Intervention

Before the intervention began, *QuickSmart* students were grouped into pairs of similar ability. Students then participated in approximately 26 weeks of structured intervention activities in small groups of two students. An experienced teacher or teacher's aide delivered the program under the supervision of a trained teacher and university instructor to ensure the fidelity of the intervention. Each small group of students attended three 30-minute ses-

sions per week for the duration of the *QuickSmart* program.

QuickSmart reading intervention sessions were structured to include a number of short and focused activities aimed at improving students' speed of word recognition, reading fluency, and comprehension skills. Each week, the three reading intervention sessions included timed flashcard activities based on a set of focus words selected from a target text; vocabulary activities; repeated readings of the target text to improve students' reading fluency; scaffolded use of comprehension strategies, such as the 3H Strategy (Graham & Wong, 1993); reading games designed to consolidate students' word recognition and word meaning knowledge; and regular testing on selected tasks from the CAAS.

Mathematics intervention sessions included a similar variety of short, focused activities that aimed to increase students' strategy use and improve their automatic recall of basic number facts across all four operations. Mathematics intervention sessions included timed recall of basic number facts from a targeted set of focus number facts, speed sheets that also related to the same set of focus facts and included extension number facts (e.g., 50×5 ; $300 \div 6$), opportunities to consolidate the use of strategies for calculating number facts, the use of a prompt scaffold to solve mathematical problems, and regular testing on tasks from the CAAS bank of mathematics tasks.

Results

The data collected during the *QuickSmart* intervention were gathered in accordance with the theoretical orientation of the program. Information related to students' accuracy and information retrieval times as measured by CAAS tasks was collected to provide a measure of students' levels of automaticity of basic academic skills. It is important to note that the development of students' fluency with number

facts in the mathematics group and word recognition in the reading group was a clear, but not the sole, focus of the intervention. Students' pretest and posttest standardized PAT scores were also gathered. The PAT scores were used as an indication of students' capacity to engage successfully with more complex tasks, such as mathematical problem solving and text comprehension. All test results were supported by the collection of rich observational data, semistructured exit interviews and field notes, and parent and teacher interviews. The discussion of these qualitative data, however, is beyond the scope of the current article.

Standardized Test Scores

The *Progressive Achievement Tests* (Australian Council for Educational Research, 1997) in mathematics for the mathematics group and in reading comprehension for the reading group were administered to students participating in the *QuickSmart* program and also to a comparison group of their high- and average-achieving peers. Increased scores on standardized tests are a stringent way to measure improvement in the performance of stu-

dents with LD (Simmerman & Swanson, 2001). In this study, 67 of the 84 participating *QuickSmart* students increased their posttest percentile rank scores. Individual improvements of up to 48 percentile points were noted.

Table 1 displays the pretest and posttest standardized test scores of the *QuickSmart* and comparison students. These results illustrate the extent of the performance gap that exists between students with LD and their high- and average-achieving peers. At pretest, the *QuickSmart* reading and mathematics groups' average scores were, respectively, 32.64 and 35.01 percentile points lower than the high- and average-achieving comparison students' scores. At posttest, this difference was 25.10 and 21.06 percentile points lower, respectively. Small and unequal sample sizes precluded further quantitative analysis of data comparing the *QuickSmart* and comparison groups.

Paired sample *t* tests indicated that the *QuickSmart* students' posttest scores were significantly higher than their pretest standardized scores on measures of comprehension, $t(1, 41) = 2.74, p = .009$, and mathematics, $t(1, 41) = 6.80, p = .000$. In contrast, the com-

parison students did not make significant gains on the standardized measures of comprehension, $t(1, 9) = 1.24, p = .245$, or mathematics, $t(1, 9) = 0.46, p = .653$, over 26 weeks. These findings can be interpreted as support for the position that improving students' accuracy and automaticity of basic academic skills, which was a focus of the *QuickSmart* program, can result in increased performance on standardized tests designed to measure proficiency on complex skills such as reading comprehension and problem solving.

In exploring these results, it is important to note that when the comparison students were separated into high-achieving and average-achieving groups, the means of the average-achieving students ($n = 5$ in each intervention group) were only marginally higher (posttest reading comprehension, $M = 49.4, SD = 16.6$; posttest mathematics, $M = 49.5, SD = 18.76$) than those obtained by the *QuickSmart* students ($n = 42$; posttest reading comprehension, $M = 44.3, SD = 20.8$; posttest mathematics, $M = 44.24, SD = 20.1$). Although the sample size of average-achieving students was small, the gap between their achievement and that of the *QuickSmart* students had not continued to widen but had narrowed dramatically over the course of the intervention.

TABLE 1

Pretest and Posttest Standardized Test Scores for *QuickSmart* Intervention and Comparison Group Students by Intervention Type

Standardized test score	QS ^a		Comp ^b	
	M	SD	M	SD
Mathematics intervention				
PAT Mathematics				
Pretest	21.67	16.7	56.68	25.4
Posttest ^c	44.24*	20.1	65.30	14.7
Reading intervention				
PAT Comprehension				
Pretest	27.86	21.7	60.50	22.9
Posttest ^d	44.30*	20.8	69.40	19.1

Note. QS = *QuickSmart* intervention group, students with learning difficulties; Comp = comparison group, high-achieving and average-achieving students; PAT = *Progressive Achievement Tests* (Australian Council for Educational Research, 1997, 2001).

^a $n = 42$. ^b $n = 10$. ^c $t(1, 41) = 6.80, p = .000$. ^d $t(1, 41) = 2.74, p = .009$.

* $p < .001$.

Cognitive Aptitude Assessment System

The CAAS system records data relating to students' retrieval times and accuracy levels on key academic tasks. For the *QuickSmart* mathematics group, the tasks used were addition number facts, subtraction number facts, multiplication number facts, division number facts, and triple addition tasks (e.g., $7 + 4 + 3$). The *QuickSmart* reading group completed CAAS assessments on Simple Word Recognition, Middle Word Recognition, Simple Cloze Sentence Comprehension, Middle Cloze Comprehension, and Nonword Reading tasks. Assessments on all of these tasks were completed before and after

the intervention with students from the *QuickSmart* group ($n = 42$) and with their high- and average-achieving peers ($n = 10$). Moreover, students in the intervention group completed CAAS assessments on a relevant task as a usual part of their *QuickSmart* lessons.

The main purpose of including a small sample of comparison students in the study was to provide a benchmark of the level of performance of same-age peers that *QuickSmart* students should aspire to in terms of response speed and accuracy on basic academic skill tasks. Figures 1 and 2 contrast the average performance profiles of the *QuickSmart* ($n = 42$) and comparison students ($n = 10$) before and after the intervention.

Figure 1 shows how the *QuickSmart* reading students improved their response speed and accuracy levels on reading tasks compared to their high-

and average-achieving peers. Whereas the comparison group's profile on reading tasks remained similar across the assessments, the *QuickSmart* students improved by an average of almost 2 seconds per response for some tasks. The *QuickSmart* students also improved in terms of accuracy. For example, on average, *QuickSmart* students improved their correct recognition of middle-level words from 62% at pretest to 90% at posttest. They also demonstrated considerable improvement (from 84% to 92%) on middle-level cloze comprehension sentence tasks. *QuickSmart* students' accuracy scores on the CAAS nonword task changed from an average of 77% at pretest to 83% at posttest. Nonword reading is recognized as a difficult task for students with learning disabilities (Siegel, 2003).

Comparison of all the pretest and posttest mathematics graphs depicted

in Figure 2 shows that the average performance of *QuickSmart* students improved markedly in terms of their immediate recall of basic mathematical facts and the accuracy of their answers. For example, with regard to multiplication number facts, the students in the *QuickSmart* group were able to respond in an average time of 2.2 seconds by the end of the *QuickSmart* program. At the beginning of the intervention, these same students took an average of 3.5 seconds to answer each number fact. The students' accuracy also improved from an average of 76% at the beginning of the program to 89% for correct multiplication number facts at the end of the intervention.

Overall, Figure 2 illustrates how mathematics students' average information retrieval times decreased from pretest to posttest and how concomitant accuracy levels increased in comparison to the performance of their

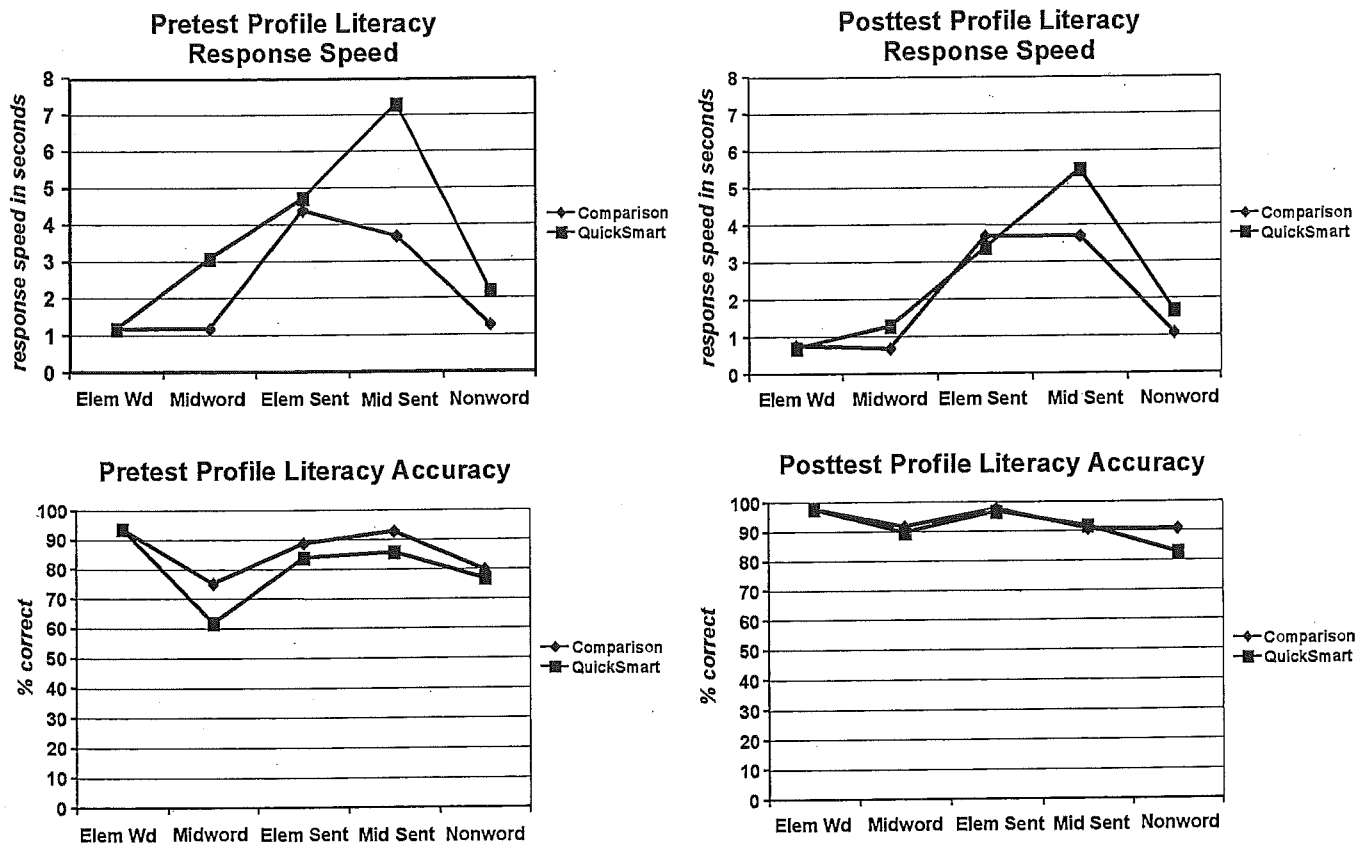


FIGURE 1. Response speed and accuracy profiles of *QuickSmart* reading intervention and comparison students.

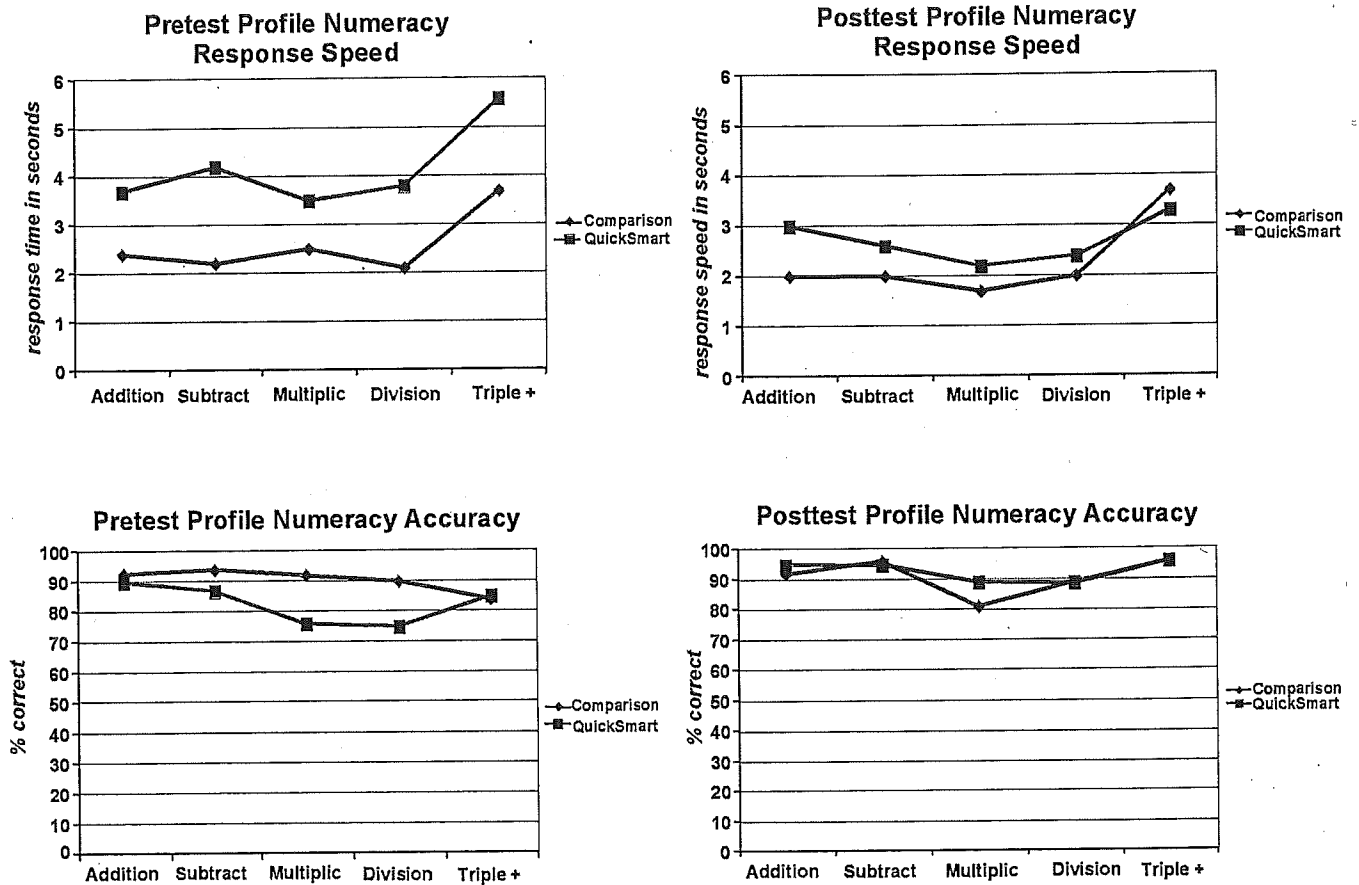


FIGURE 2. Response speed and accuracy profiles of *QuickSmart* numeracy intervention and comparison students.

high- and average-achieving peers. Again, these graphs are indications of how *QuickSmart* students were able to narrow the gap in terms of basic academic skills by becoming "quicker" with fact retrieval and "smarter" at strategy use.

Discussion

QuickSmart focuses on improving the automaticity of basic academic skills of students with persistent learning difficulties in their middle years of schooling. The results from this exploratory, field-based intervention indicate that students who completed the *QuickSmart* program were able to achieve a profile of performance on CAAS response speed and accuracy measures similar to that of their age-matched peers. Indeed, it would be reasonable

to expect that participating students who received up to 26 weeks of *QuickSmart* lessons—that is, those not usually responsive to instruction—would make gains on measures of response speed and accuracy that were the focus of the program. Figures 1 and 2 confirm that on CAAS reading and mathematics posttests, there was little difference between the *QuickSmart* and comparison groups. The *QuickSmart* students' improvement in accuracy levels was particularly notable.

Although further work with a larger cohort of comparison students, a control group to address concerns about external validity, and more rigorous statistical analyses are necessary, this study has demonstrated that carefully designed explicit interventions of sufficient intensity and duration, such as *QuickSmart*, have promise. They can begin to bring students "up to speed"

in terms of efficient processing. These results contradict research (e.g., Geary, 1996; Spear-Swerling, 2005; Westwood, 2003) suggesting that the ability to retrieve basic facts does not usually improve across the elementary school years for most students with LD. Providing frequent opportunities for practice, for feedback, and for fluent performance supported *QuickSmart* students as they moved from being unsure of basic academic knowledge and reliant on inefficient strategies to being able to "trust their heads," as some participating students termed it, because automatic recall had been established.

It appears that even small decreases in the time that it takes students to complete basic number fact or word recognition tasks can accrue benefits. These benefits associated with increased efficiency of working memory

include more successful engagement with complex tasks (van der Sluis, van der Leij, & de Jong, 2005) and, with success, a stronger sense of control over learning (Westwood, 2004). To illustrate, during an interview at the end of the *QuickSmart* program, one of the students exclaimed with surprise, "I didn't know I could read like that. I sound just like the good kids."

How students' improvement on basic academic skills such as number facts and word recognition influenced their ability to tackle more demanding tasks like reading comprehension and mathematical problem solving was investigated through the administration of standardized tests normed on a population of Australian schoolchildren. These tests were included as a way of gaining some insight into whether students' higher order thinking had improved alongside their automaticity with basic academic skills. Whether standardized tests are an appropriate measure for accessing students' improvements in cognitive processing can be debated. They are, however, unbiased, ecologically valid measures that are independent of the researchers and the major intervention focus on developing automaticity (see Simmerman & Swanson, 2001).

The statistically significant improvements of the *QuickSmart* reading and mathematics groups on these measures of more generalized reading or mathematics knowledge, skills, and understanding indicate that the students had become more able to complete these kinds of tasks successfully by the end of the intervention. This improvement was not evident in the scores of the high- and average-achieving students in the comparison groups. The gap between the comparison and *QuickSmart* students remained but had narrowed by the end of the intervention, particularly in terms of the mean scores of the five average-achieving students included in each of the comparison groups. This finding has value at a time in Australia when state and national testing agendas are increasingly pervasive.

Due to the nature of their difficulties, some middle school students with LD may never catch up with their peers without LD in terms of academic achievement. For most students who experience LD, however, a worthy aim is to "narrow the gap," so that their achievement levels match or are closer to those of their average-achieving peers. The results of this research suggest that a focus on improving basic academic proficiency through a targeted intervention has considerable potential because it boosts the kinds of skills that are necessary for more complex tasks that are assumed to already be in place for middle school students (Milton & Forlin, 2003). Curriculum demands and the diversity of student needs in the classroom generally do not allow teachers the time to organize and oversee instruction with the specific focus, fast-paced opportunities for practice, and individual attention to progress that *QuickSmart* offers. Many of the activities in *QuickSmart* lessons can be and are used in classroom settings. The small-group instruction described in this article, however, presents an alternative way of addressing the learning needs of students experiencing LD by consolidating their knowledge and confirming their proficiency so that they are ultimately more able to benefit from classroom instruction.

In general, the achievement of the students who participated in the *QuickSmart* program underscores the importance of theory-based interventions. Such interventions, when adapted to local contexts and focused on particular curriculum demands, have the potential to make a positive difference to students' academic performance. *QuickSmart* is also a program that responds to Australian policy directions and initiatives. The goals of the *QuickSmart* intervention are closely aligned to the *Adelaide Declaration on National Goals for Schooling in the 21st Century* (Committee of Australian Governments, 1999), which states that students should attain "the skills of numeracy and English literacy; such that every

student should be numerate, able to read, write, spell and communicate at an appropriate level" and that schools should be socially just so that "the learning outcomes of educationally disadvantaged students improve and, over time, match those of other students."

Moreover, the structured approach of the *QuickSmart* program, with its use of technology and emphasis on practice and strategy, is very much in tune with how many researchers consider students with LD can be most usefully supported (Ellis, 2005; Hay, Elias, & Booker, 2005; Swanson, 2000). In terms of Australian research into learning difficulties, *QuickSmart* is an example of a third-wave teaching intervention, designed for students with academic difficulties in the middle years of schooling whose difficulties have not responded to the assistance offered by their teachers, consultants, and classroom-based learning support programs (Louden et al., 2000). It offers a flexible model of intense, focused, supported, small-group instruction over an extended timeframe. In this way, *QuickSmart* complements current initiatives that focus on quality teaching and teacher development (e.g., Rowe, 2006) by addressing the needs of middle school students directly. The *QuickSmart* program is individualized, carefully monitored, and accompanied by professional development opportunities for teachers, aides, support teachers, and other members of school communities.

This research was the first of a series of studies that have subsequently refined the intervention and explored *QuickSmart* students' maintenance of performance gains over time in comparison to their peers and to other groups of students with LD. Further research, however, is essential to establish the most productive ways of working with classroom and support teachers, the optimal years of school in which to offer the *QuickSmart* intervention, and the feasibility of providing both reading and mathematics programs to the same students.

Long-term programmatic intervention research is necessary because there are no easy answers for students who have LD. It takes considerable resources to offer an intervention such as *QuickSmart* to those students who would benefit from it. The importance of control and comparison groups adds further to the cost and complexity involved. However, such work is essential so that an important option of support for students with LD is not lost, but carefully explored and fully justified. Only further controlled intervention research in Australian schools will ameliorate the situation mooted by Carlisle and Rice (2002), where "many of the instructional practices that have the most potential to make a meaningful difference for students with LD and other poor readers are seldom employed" (p. 148).

ABOUT THE AUTHORS

Lorraine Graham, PhD, is associate director of student diversity in the National Centre of Science, Information and Communication Technology and Mathematics Education for Rural and Regional Australia (SiMERR) and a senior lecturer in the School of Education at the University of New England, New South Wales. Her research interests include intervention research, effective instruction, comprehension strategies, and issues related to rural schooling. Anne Bellert, BEd, is a learning support officer with the Catholic Education Office in Lismore, New South Wales. She is currently completing a postgraduate degree at the University of New England. Jenny Thomas, MEd, is an experienced special educator and research associate at the University of New England. John Pegg, PhD, is a professor of mathematics education and director of the National Centre of Science, Information and Communication Technology and Mathematics Education for Rural and Regional Australia (SiMERR). Address: Dr Lorraine Graham, SiMERR/School of Education, University of New England, Armidale, NSW, 2351, Australia; e-mail: lgraham@une.edu.au

AUTHORS' NOTE

This research was funded by an Australian Research Council Discovery Grant to John Pegg, Lorraine Graham, and James Royer (DP0345508). The authors would like to ac-

knowledge the contribution of the principals, teachers, and students who participated in this project.

REFERENCES

- Australian Council for Educational Research. (1997). *Progressive achievement tests in mathematics-Revised*. Melbourne: Author.
- Australian Council for Educational Research. (2001). *Progressive Achievement Tests in Reading: Comprehension and Vocabulary. Teacher's manual*. Melbourne: Author.
- Anderson, J. R. (1981). *Cognitive skills and their acquisition*. Hillsdale, NJ: Erlbaum.
- Bellert, A., & Graham, L. (2006). Caught in the middle: Reaching and teaching middle years students with learning difficulties. *Australian Journal of Middle Schooling*, 6(1), 3-10.
- Burns, M., Griffin, P., & Snow, C. (1999). *Starting out right: A guide to promoting children's reading success*. Washington, DC: National Academy Press.
- Carlisle, J. F., & Rice, M. S. (2002). *Improving reading comprehension: Research-based principles and practices*. Baltimore: York Press.
- Cawley, J. F., Fan Yan, W., & Miller, J. H. (1996). Arithmetic computation abilities of students with learning disabilities: Implications for instruction. *Learning Disabilities Research & Practice*, 11, 230-237.
- Chan, L., & Dally, K. (2001). Learning disabilities: Literacy and numeracy development. *Australian Journal of Learning Disabilities*, 6(1), 12-19.
- Committee of Australian Governments. (1999). *Adelaide declaration on national goals for schooling in the 21st century*. Retrieved September 25, 2006, from http://www.dest.gov.au/sectors/school_education/policy_initiatives_reviews/national_goals_for_schooling_in_the_twenty_first_century.htm
- Deschler, D. D. (2005). Adolescents with learning disabilities: Unique challenges and reasons for hope. *Learning Disability Quarterly*, 28, 122-124.
- Doyle, W. (1983). Academic work. *Review of Educational Research*, 53, 159-199.
- Ellis, L. A. (2005). *Balancing approaches: Revisiting the educational psychology research on teaching students with learning difficulties* (Australian Education Review 48). Camberwell, Victoria: Australian Council for Educational Research.
- Fodor, J. (1985). Précis of the modularity of mind. *Behavioral and Brain Sciences*, 8, 1-42.
- Geary, D. C. (1996). *Children's mathematical development*. Washington, DC: American Psychological Association.
- Geary, D. C. (2004). Mathematics and learning disabilities. *Journal of Learning Disabilities*, 37, 78-89.
- Graham, L. (1993). *The comparative effectiveness of a question-answer relationship strategy for improving the reading comprehension of learning-disabled and low-achieving readers*. Unpublished doctoral dissertation. Simon Fraser University, Vancouver, BC, Canada.
- Graham, L., & Bellert, A. (2005). Reading comprehension difficulties experienced by students with learning disabilities. *Australian Journal of Learning Difficulties*, 10(2), 71-78.
- Graham, L., & Wong, B. Y. L. (1993). Comparing two modes in teaching a question-answering strategy for enhancing reading comprehension: Didactic and self-instructional training. *Journal of Learning Disabilities*, 26, 270-279.
- Hay, I., Elias, G., & Booker, G. (2005). *Schooling issues digest: Students with learning difficulties in relation to literacy and numeracy*. Canberra: Australian Commonwealth Department of Education, Science and Training. Retrieved April 16, 2006, from http://www.dest.gov.au/sectors/school_education/publications_resources/schooling_issues_digest/schooling_issues_digest_learning_difficulties.htm
- Hempenstall, K. J. (2005). How might a stage model of reading development be helpful in the classroom? *Australian Journal of Learning Disabilities*, 10(3-4), 35-52.
- La Berge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology*, 6, 293-323.
- Louden, W., Chan, L. K. S., Elkins, J., Greaves, D., House, H., Milton, M., et al. (2000). *Mapping the territory: Primary students with learning difficulties: Literacy and numeracy. Vol. 1: Overview*. Canberra, Australia: Department of Education, Training and Youth Affairs.
- Milton, M. (2000). How do schools provide for children with difficulties in numeracy? *Australian Journal of Learning Disabilities*, 5(2), 23-27.
- Milton, M., & Forlin, C. (2003). Supporting students with learning difficulties in a secondary school. *Special Education Perspectives*, 12(1), 31-46.
- Perfetti, C. A. (1988). Verbal efficiency in reading ability. In G. E. MacKinnon, T. G. Waller, & M. Daneman (Eds.), *Reading*

- research: *Advances in theory and practice* (Vol. 6, pp. 109–143). San Diego: Academic Press.
- Perfetti, C. A. (1992). The representation problem in reading acquisition. In P. Gough, L. Ehri, & R. Treiman (Eds.), *Reading acquisition*. Hillsdale, NJ: Erlbaum.
- Pincott, R. (2004). Are we responsible for our children's math difficulties? In B. A. Knight & W. Scott (Eds.), *Learning difficulties: Multiple perspectives* (pp. 141–151). French's Forest, Australia: Pearson.
- Rowe, K. J. (2006, July 14). *Effective teaching practices for students with and without learning difficulties: Constructivism as a legitimate theory of learning AND teaching?* Background paper to keynote address presented at the New South Wales Department of Education and Training Office of Schools Portfolio Forum, Wilkins Gallery, Sydney, Australia.
- Royer, J. M. (1996). Cognitive assessment of reading competencies: Diagnosis and prescription. In G. D. Phye (Ed.), *Handbook of academic learning* (pp. 199–234). San Diego: Academic Press.
- Royer, J. M., & Tronsky, L. N. (1998). Addition practice with math disabled students improves subtraction and multiplication performance. *Advances in Learning and Behavioural Disabilities, 12*, 185–217.
- Shiffrin, R., & Dumais, S. (1981). The development of automatism. In J. R. Anderson (Ed.), *Cognitive skills and their acquisition*. Hillsdale, NJ: Erlbaum.
- Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing II: Perceptual learning, automatic attending, and a general theory. *Psychological Review, 84*, 127–190.
- Siegel, L. (2003). Basic cognitive processes and reading disabilities. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities*. New York: Guilford Press.
- Simmerman, S., & Swanson, H. L. (2001). Treatment outcomes for students with learning disabilities. How important are internal and external validity? *Journal of Learning Disabilities, 34*, 221–236.
- Spear-Swerling, L. (2005). Components of effective mathematics instruction. *LD Online: LD in Depth*. Retrieved August 10, 2006, from <http://www.Idonline/lddepth/effective-mathematics.html>
- Spring, C., & French, L. (1990). Identifying children with specific reading disabilities from listening and reading discrepancy scores. *Journal of Learning Disabilities, 23*, 53–58.
- Stanovich, K. E. (1990). Concepts in developmental theories of reading skill: Cognitive resources, automaticity and modularity. *Developmental Review, 10*, 72–100.
- Swanson, H. L. (2000). Issues facing the field of learning disabilities. *Learning Disability Quarterly, 23*, 37–58.
- Swanson, H. L., & Hoskyn, M. (2001). Instructing adolescents with learning disabilities: A component and composite analysis. *Learning Disabilities Research & Practice, 16*, 109–119.
- Thompson, G. B., & Nicholson, T. (1999). *Learning to read: Beyond phonics and whole language* (Language and Literacy Series). New York: Teachers College Press.
- Torgesen, J. K. (2000). Individual differences in response to early intervention reading: The lingering problem of treatment resisters. *Learning Disabilities Research & Practice, 15*, 55–64.
- van der Sluis, S., van der Leij, A., & de Jong, P. F. (2005). Working memory in Dutch children with reading- and arithmetic-related LD. *Journal of Learning Disabilities, 38*, 207–221.
- Vaughn, S., Bos, C. S., & Schumm, J. S. (1997). *Teaching exceptional, diverse and at-risk learners in the general education classroom* (2nd ed.). Boston: Allyn & Bacon.
- Vaughn, S., Gersten, R., & Chard, D. (2000). The underlying message in LD intervention research: Findings from research syntheses. *Exceptional Children, 67*, 99–114.
- Walczyk, J. J. (2000). The interplay between automatic and control processes in reading. *Reading Research Quarterly, 35*, 554–566.
- Westwood, P. (1993). Mixed ability teaching: Issues of personalization, inclusivity and effective instruction. *Australian Journal of Remedial Education, 25*(2), 22–26.
- Westwood, P. (2003). Drilling basic number facts: Should we or should we not? *Australian Journal of Learning Disabilities, 8*(4), 12–18.
- Westwood, P. (2004). The affective components of difficulty in learning: Why prevention is better than attempted cure. In B. A. Knight & W. Scott (Eds.), *Learning difficulties: Multiple perspectives*. French's Forest, Australia: Pearson.
- Westwood, P., & Graham, L. (2000). How many children with special needs in regular classes: Official predictions vs. teachers' perceptions in South Australia and New South Wales. *Australian Journal of Learning Disabilities, 5*(3), 24–35.
- Wolf, M. (1991). Naming speed and reading: The contribution of the cognitive neurosciences. *Reading Research Quarterly, 16*, 123–141.
- Wolf, M., & Bowers, P. (1999). The double deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91*, 1–24.
- Wolf, M., Miller, L., & Donnelly, K. (2000). Retrieval, automaticity, vocabulary elaboration, orthography (RAVE-O): A comprehensive, fluency-based reading intervention program. *Journal of Learning Disabilities, 33*, 375–389.