Developing Assessment Profiles for Mathematically Gifted Children With Learning Difficulties at Three Schools in Cambridgeshire, England

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This paper focuses on critical issues related to the identification of mathematically gifted children with learning difficulties (LDs). One purpose of the study is to broaden teachers' and educators' insight into the identification of gifted students with LDs, sometimes referred to as dual-exceptional children. A multiple case study approach was adopted and 5 case study profiles of mathematically gifted students with LDs in Years 4–6, ages 9 to 11 years and 5 months, were developed. An assessment plan was used to combine aspects of LDs and giftedness in an attempt to provide a multidimensional evaluation. The students received a multidimensional assessment, which indicates that psychometric test scores need to be supplemented with dynamic and informal assessments; historical data; task analysis of permanent products; and information from parents, teachers, and students.

The conceptual approach of this research subsumes the belief that giftedness and learning difficulties (LDs) can occur concurrently in the same individual. This understanding emerged from using broader definitions of giftedness and learning difficulties, which allow for students with both exceptionalities to be identified. The predominant belief since Terman's (1925) time has been that gifted children uniformly score high on intelligence tests and perform well in school (Brody & Mills, 1997), and that demonstrating a high potential in one area means that a child has high potential in other areas. This simplistic understanding was challenged by the emergence of more sophisticated definitions of giftedness, such as those of Marland (1972), in which more populations were included into the gifted category. The direct link between high performance or IQ and being gifted was lost. However, the new and broader definitions have caused

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confusion in student selection, identification, characteristics, and program planning.

During the last three decades, increasing attention has been given to the pressing question of "dual-exceptional" children, or more able students who also have specific LDs. According to Baum (1989) and Brody and Mills (1997), these dual-exceptional children who remain unrecognized can be classified into at least three subgroups. The first subgroup comprises students with hidden LDs, including students who are identified as gifted yet exhibit difficulties in school or, as Baum described them, "gifted students who have subtle LDs" (p. 1). This group is easily identified as gifted; however, the gap between what is expected and their actual performance is often wide (Fetzer, 2000). The second subgroup consists of students with hidden giftedness, students whose LDs are severe enough that they have been identified as having LDs, but whose high abilities have never been addressed or recognized. They are first noticed for what they cannot do, rather than for the talent they also demonstrate (Brody & Mills, 1997; Little, 2001). Students in the third subgroup and "perhaps the largest group of non-served and unidentified students" (Brody & Mills, 1997, p. 2) are those whose high abilities and LDs mask each other (Baum, 1989; Brody & Mills, 1997). These students sit in regular classrooms, are not considered as qualifying for services provided for students who are gifted or have LDs, and are regarded as possessing average abilities (Brody & Mills, 1997).

In order to identify dual-exceptional students, a number of assessment strategies are recommended in the literature. For example, a multidimensional approach to identification is recommended by Lazarus (1989) to determine the areas of strength and weakness of gifted children with LDs. The rationale for using a multidimensional approach is as follows: (a) The British version of the Wechsler Intelligence Scale for Children (WISC-III^{UK}) is a good means of identifying cognitive strengths and weaknesses; (b) Verbal, Performance, or Full-Scale scores, or Verbal-Performance discrepancies tend to obscure the subtly distinctive patterns that characterize and identify the various gifted/LD groups; (c) a dynamic assessment approach can provide a means of assessing potential development of dyslexic and underserved gifted students and of determining the discrepancy between potential and performance (Haywood & Lidz, 2007; Kanevsky, 2001; Kirschenbaum, 1998); and (d) important information can be obtained from parents and teachers about the academic and social activities of the children, which may not be demonstrated using standardized tests.

The current research is grounded in two main approaches: the use of broad definitions of giftedness and LDs, which are widely used in the Cambridgeshire County schools, the location of the study; and the tendency to use a multidimensional assessment without which any approach to assess dual-exceptional students will remain inadequate. The purpose of this research was twofold: (1) to investigate the efficacy of a multidimensional assessment that encompasses informal, psychometric, and dynamic assessment for identifying mathematically gifted children with specific learning difficulties; and (2) to develop assessment profiles for those students based on their distinctive literacy patterns and cognitive strengths and weaknesses.

Identification of Gifted Students With Learning Difficulties

In the field of exceptional and dual-exceptional children, identification is always related to definitions. Accordingly, nebulous definitions of giftedness and learning difficulties generate problems in identifying gifted children with LDs. The major difficulty in identifying those students is that there are many gifted children with LDs who fail to meet the qualification requirements for either gifted programs or special needs services. Research has shown that teachers are much more likely to refer gifted students who do not have LDs than gifted students who do have LDs for placement in gifted and talented programs (Minner, 1990), because students with LDs who are gifted rarely show consistently high academic achievement and usually go unrecognized as being gifted and eligible for special programs (Baum, 1989; Beckley, 1998; Brody & Mills, 1997; Ruban & Reis, 2005).

Some educators (e.g., Brody & Mills, 1997; Fetzer, 2000) have suggested a flexible, multidimensional approach to identification, which they argue is necessary to determine areas of strength and weakness. This approach includes an individual test of intelligence, academic tests to determine the discrepancy between potential and performance, a test of creativity to assess abilities that may not emerge from cognitive ability measures, and dynamic assessment in addition to teachers' and parents' reports (Thomson, 2001). Recently, McCoach, Kehle, Bray, and Siegle (2004) have proposed a comprehensive longitudinal system for identifying gifted students with LDs with behavioral observation, an individual intelligence test, measures of cognitive processing, and a full achievement battery. The proposed identification system also suggests assessing the student's level of functioning in the regular classroom environment, using curriculum-based assessment, and interviewing students to assess their perceptions and attitudes toward academic work.

Baum and Owen (2004) reported that, to recognize the potential for gifted behavior in students with LDs, educators should generally approach the identification process in two ways: (a) *a priori* identification, entailing collection and analysis of test data and interview information about students; and (b) dynamic identification, involving the use of activities purposely designed to elicit creative responses and signal possible areas of student talent. Four defining characteristics of these students should be considered (Al-Hroub, 2005; Brody & Mills, 1997), including evidence of an outstanding talent or ability, evidence of an aptitude-achievement discrepancy, evidence of verbal-performance IQ discrepancy, and evidence of a processing deficit.

Evidence of an Outstanding Talent or Ability

Brody and Mills (1997) suggested the necessity of using a variety of assessments, including intelligence tests, aptitude and achievement tests, dynamic assessment, teacher nominations, creativity tests, interviews, and behavioral observations. Munro (2002) recommended that the identification process should involve collecting data in a range of areas, including evidence of: (a) superior cognitive or reasoning ability; (b) academic aptitude, probably in areas outside the school; (c) creative or productive thinking, (d) superior achievement in areas outside the school; and (e) a high level of intrinsic motivation to learn in areas of interest.

Evidence of an Aptitude-Achievement Discrepancy

McCoach et al. (2004) pointed out that many researchers and psychologists rely on the use of an IQ-achievement discrepancy formula to identify gifted students with LDs, and that if this approach is eliminated by the American federal definition of LDs, identifying these students becomes increasingly difficult. According to McCoach et al., gifted students with LDs may indeed exhibit relative discrepancies between their potential and performance, but they may not exhibit academic deficits when compared to their peers. Therefore, gifted students who achieve average levels or slightly below average levels academically are difficult to diagnose as gifted with LDs without inspecting the discrepancy between their superior potential and their average academic performance.

Kavale (2002) indicated that intellectual ability-achievement discrepancy is the operational definition of underachievement and, when present, reliably and appropriately documents the presence of underachievement, not LDs. However, when placed in the proper educational context, any arguments against the use of discrepancy to determine LDs are eliminated. It would, therefore, be a mistake to ignore discrepancy when considering the best means of defining the constructs.

Evidence of Verbal-Performance IQ Discrepancy

In the field of gifted children with LDs, numerous researchers (e.g., Barton & Starnes, 1989; Kaufman, 1994; Ryckman, 1981; Schiff, Kaufman, & Kaufman, 1981; Waldron & Saphire, 1990) have shown that a discrepancy is notable between the verbal and performance parts of the second and third American versions of the Wechsler Intelligence Scale for Children (WISC-R and WISC-III). Silverman (1983) indicated that gifted students with LDs may have a 15-point discrepancy between verbal and performance scores VIQ-PIQ on the WISC-R. The WISC-III manual (Wechsler, 1992) gives values for statistical significance to determine whether the VIQ-PIQ discrepancy is significant. The overall values for discrepancy are 11 points at the .05 level and 15 points at the .01 level (Kaufman, 1994). Al-Hroub (2005) reported a significant (VIQ-PIQ) discrepancy, with verbal scores higher for a group of mathematically gifted students with LDs, whereas Waldron and Saphire (1990) found that significant discrepancies between verbal and performance scores may not be the best indicator of a learning difficulty in students. Brody and Mills (1997) reported that there are inconsistencies in magnitude or direction of verbal and performance IQ discrepancy among studies that characterized giftedness with LDs.

Evidence of a Processing Deficit

It is crucial to distinguish between LDs and other learning problems caused by factors such as general low ability, lack of opportunity to learn, poor teaching, emotional problems, and inappropriate curriculum. Munro (2002) stressed the difficulty in identifying this condition because low achievement may be due to a range of causes, such as Attention Deficit/Hyperactivity Disorder (ADHD), socioeconomic status or culture, and/or LDs. Differentiating diagnosis is therefore very important when making decisions regarding the need for identification and intervention (Beckley, 1998; Brody & Mills, 1997).

Who Are Mathematically Gifted Students?

Several theorists argued that there is no universally accepted definition of general giftedness (Gagné, 1995; Renzulli, 1977; Sternberg & Davidson, 2005) that extends to mathematics (Reed, 2004). Sowell, Zeigler, Bergwall, and Cartwright (1990) documented a variety of literature-based objectives to describe exceptionally gifted mathematics students, characterizing them as "promising," "high-end learners," "gifted and talented," and "academically superior" (p. 147). Miller (1990) pointed out that descriptions such as "mathematically talented," "mathematically gifted," and "highly able in mathematics" are generally used to refer to students whose mathematical ability places them in the top 2% or 3% of the population. Despite such different descriptions of gifted students with high mathematical potential, Sowell et al. argued that mathematically gifted students are those who are precociously able to solve mathematical problems that are typically accomplished by older students or engage in qualitatively different mathematical thinking processes than those of their classmates or chronological peers. Krutetskii (1976) contended that the tendency to see the world through mathematical eyes is obvious in students who are gifted in mathematics. After a careful review of the literature, Krutetskii arrived at the following definition: "Mathematical giftedness is a set of testable abilities of an individual. If she/he scores high in nearly all of these abilities, there is a high possibility of successful creative work later on in the mathematical field and related areas" (as cited in Wagner & Zimmermann, 1986, p. 246).

Krutetskii (1976) listed two characteristics that mathematically gifted students have the ability to do: (a) be persistent in their commitment to work and (b) display creativity and flexibility in their search for solutions to mathematical problems. This approach reflects Renzulli's (1977) three-ring definition of giftedness, which has task commitment and creativity as two of the cluster traits. Ball (1993) reproduced Renzulli's definition to characterize mathematically gifted students as those who have (a) above-average ability; (b) creativity in mathematics, which is the ability to respond with flexibility and creativity to a mathematical problem; and (c) task commitment in their pursuit of a solution to a mathematical problem.

In the U.S., the National Council of Teachers of Mathematics (NCTM) established a task force in 1994 that purposely chose the word *promising* rather than *gifted* or *talented* to emphasize the goal of including students who have been previously excluded because of lack of opportunity or experience (Gavin & Adelson, 2008; Sheffield, 1999). The task force defined promising students as "those who have the potential to become leaders and problem solvers of the future" (Sheffield, 1999, p. 310).

Mathematically Gifted and Learning Difficulties

Some mathematically gifted students do not necessarily demonstrate outstanding academic achievement, display enthusiasm toward school mathematics programs, or obtain top grades in mathematics. There are many possible reasons why these students may not be doing well, but often it is, at least in part, because of a mismatch between the needs of the student and the mathematically gifted programs. Many students refuse, or are unable, to conform to the expectations of programs (Miller, 1990), which can be a result of their specific LDs.

According to Krutetskii's (1976) concept, mathematically gifted students may show an outstanding talent in mathematics accompanied by deficits in other areas. An instance of early mathematical giftedness was described in 1964 by psychologists in the German Democratic Republic. S. Reiner's parents first paid attention to his abilities when he was 5 years old. After 1 year at school, he went directly into the second grade. According to the experimenters, although Reiner showed remarkable skills in arithmetic and problem solving, he had considerable difficulty in studying language and spelling (Krutetskii, 1976). Leonardo da Vinci (1452–1519), the remarkable Florentine artist, architect, engineer, and mathematician, is another case of dyslexic genius. An example of his "mirror writing," a distinctive symptom of LDs, may be seen in his notebooks exhibited at the British Museum in London (Aaron, Joshi, & Ocker, 2004).

A controlled comparison study of the performance of dyslexics in mathematics was carried out by Steeves (1983). Her subjects were 54 dyslexic students between the ages of 10 and 14 years, and 54 suitably matched controls. The researcher divided them into four groups, namely, (a) dyslexic high (DH), dyslexics with a high score on the Raven's Standard Progressive Matrices; (b) dyslexic average (DA), dyslexics with an average score on the Raven's; (c) non-dyslexics in a mathematics class for those of high ability (NH); and (d) non-dyslexics in a mathematics class for those of average ability (NA). The DH group was at the same level as the NH group in the Raven's; in a mathematics school test, however, they were on a level with the NA group, with lower scores than both of the non-dyslexic groups in the Wechsler Memory Test. The DA group was on a level with the NA group in the Raven's Standard Progressive Matrices, but below them in the other two tests, and was particularly weak in the Wechsler Memory Test.

Joffe (1981) gave a test of computation to 102 students ages 8–17. Half of them were dyslexics, and the other half was a control group. All had been found to be average or above in intellectual abilities in standardized tests. Ten percent of the dyslexics scored very high, whereas 60% scored well below expectation. Lewis, Hitch, and Walker (1994) explored the incidence of arithmetic difficulties within a population of more than 1,000 nine- to ten-year-olds. Approximately 4% of the sample had reading difficulties only, 2.3% had arithmetic and reading difficulties, and 1.3% had arithmetic difficulties only.

Research Questions

The issue addressed by the current research is whether multidimensional assessment can be an efficient approach to identify mathematical giftedness and LDs in the same students. A multiple case study approach was used to explore the following research questions:

1. What is the efficacy of using specific multiple measures to identify mathematically gifted students with learning difficulties?
2. What is the special academic behavior of mathematically gifted children with learning difficulties?
3. What is the nature of the relationship between students' mathematical abilities and their learning difficulties?

Method

Participants

The researcher identified five students, three males and two females, aged 9 years to 11 years and 5 months, from Years (grades) 4–6 at three primary schools in Cambridgeshire in the UK. All students' names have been changed to ensure anonymity. In the process of selecting the five cases, eight students were nominated by their teachers as being mathematically gifted with LDs. Two students were excluded; one of them showed mathematical giftedness with no LDs, and the other showed severe writing and spelling difficulties and a moderate difficulty in reading, but no evidence of high ability in mathematics.

The participants were chosen from Years (grades) 4–6 because students who have specific LDs or high ability in mathematics are difficult to recognize or identify in the earlier years of schooling. All of the students were chosen from relatively advantaged backgrounds, with English as their first language. The subjects were selected from a total population of 80 students across Years 4 to 6 in the three selected schools. Each of their classes was made up of no more than 32 students.

Students were selected according to the following criteria: recentness of placement or re-evaluation data, psychological and school reports indicating the possibility or diagnosis of high mathematical ability and/or specific LDs affecting the student's academic performance, and the willingness of the parents and schools to participate in the research.

Data Collection

A combination of six techniques for identification was used; some to identify giftedness and others to identify LDs. Each student was evaluated formally and informally for approximately 10–15 hours over 6–8 sessions. The formal and informal assessments were conducted in the following order: (a) documentary evidence; (b) teacher and parent interviews; (c) the Wechsler Intelligence Scale for Children (WISC-III^{UK}; Wechsler, 1992); (d) the Dyslexia Screening Test (DST; Fawcett & Nicolson, 1996); (e) the Neale Analysis of Reading Ability (revised British ed.; Neale, 1989); and (f) dynamic assessment involving a mathematics achievement test.

Documentary evidence. Permission was obtained from both parents and head teachers to ensure access to all information that was of clear relevance to the education of the student. The information obtained from the records included familial information, medical background, school history, cognitive test scores, aptitude test scores, psychological reports, achievement test results, teachers' anecdotal records, student's paperwork, and special education files.

Parent and teacher interviews. Interviews were conducted with the parents and teachers, as they were considered to be the best source of information about the students. In the first stage, teachers and parents were asked to complete a questionnaire. The parents were given a case history form that was designed to demonstrate that familial, physical, psychological, social, and educational histories were the main areas that were to be discussed with them. Likewise, the teachers were given a form to complete about the student's academic level, special interests, and his or her behavioral patterns. Teacher interviews focused on students' strengths and weaknesses in reading, writing and spelling, in addition to their high potential in solving mathematical problems, all of which are important in identifying any aspects of mathematical giftedness or LDs. In the second stage, teachers and parents were asked to talk about issues they felt were significant in relation to the development and education of the child concerned.

The Wechsler Intelligence Scale for Children. The WISC-III^{UK} (Wechsler, 1992) is an individually administered clinical instrument used to assess (over the course of 50–70 minutes) the intellectual ability of children ages 6–16. It consists of 13 subtests in 2 scales: verbal (6 subtests) and performance (7 subtests). Of the 13 subtests, 10 are required, 2 supplementary, and 1 is optional. Only the required subtests are used to determine IQ scores. Verbal scale subtests require students to listen to questions and answer orally. The verbal subtests are: (a) Information, (b) Similarities, (c) Arithmetic, (d) Vocabulary, (e) Comprehension, and (f) Digit Span (Supplementary). Performance subtests are visual-motor tasks that comprise: (a) Picture Completion, (b) Picture Arrangement, (c) Block Design, (d) Object Assembly, (e) Coding, (f) Symbol Search (optional), and (g) Mazes (supplementary).

In the field of giftedness and LDs, the WISC-III^{UK} is often used to gain an overall estimate of the student's global intellectual strengths and weaknesses in specific areas of aptitude. In research studies of the gifted, the sample is usually limited to those with at least one IQ score at 130 or above (Montgomery, 1996). Silverman (1989) suggested that the level for inclusion into these gifted education programs should be dropped by 10 points in the case of those with a LD. Accordingly, students in the current research study who scored 120 or above on the full IQ scale were labeled gifted.

The Dyslexia Screening Test. The Dyslexia Screening Test (DST; Fawcett, & Nicolson, 1996) provides a profile of the strengths and weaknesses often associated with dyslexia. This test is designed to identify children ages 6–16 at risk of reading failure early enough to allow children to be given extra in-school support. The DST takes approximately 30 minutes overall to administer, which is within the attention span of most children in this age group. This instrument has been designed for use by school professionals (teachers or special needs coordinators) rather than psychologists, clinical psychologists, or speech and language specialists.

The DST test battery includes three attainment and eight diagnostic subtests. The three attainment subtests are: (a) One-Minute Reading Test—measures fluency and accuracy; (b) Two-Minute

Spelling Test—gives an index of spelling fluency; and (c) One-Minute Writing Test—provides an index of speed in copying text.

The attainment subtests cover the three critical requirements for diagnosing dyslexia, however, the diagnostic subtests complement them by covering the range of skills that are known to be affected in dyslexia, and the profile of difficulties that can be used to interpret the causes of attainment problems. These subtests are: (a) Rapid Naming—measures the time it takes to name a page full of outline drawings; (b) Bead Threading—assesses hand and eye coordination; (c) Postural Stability—provides an index of balance ability; (d) Phonemic Segmentation—assesses phonological skills and working memory; (e) Backwards Digit Span Test—assesses working memory; (f) Nonsense Passage Reading—assesses the ability to read unfamiliar words; (g) Verbal Fluency—assesses verbal fluency; and (h) Semantic Fluency—assesses semantic fluency (Fawcett & Nicolson, 1996).

The test-retest stability was assessed, and a very high correlation reliability, higher than 0.90, was obtained for attainment subtests and Nonsense Passage Reading. Correlation reliability was high, 0.80 to 0.88, for Rapid Naming, Phonemic Segmentation, Backwards Digit Span, and Verbal Fluency, and satisfactory (above 0.70) for Beading Threading, Postural Stability, and Semantic Fluency. Furthermore, interrater reliability for two experienced testers was 0.98, whereas the interrater reliability between the inexperienced tester and each of the experienced testers was 0.94. Construct validity was assessed by administering the DST to a group of 17 children previously diagnosed as dyslexic. The results show that all but two of the children had an "at risk quotient" of 1 or more, as would be expected for a screening diagnosis of a child being "at risk" (Fawcett & Nicolson, 1996).

The Neale Analysis of Reading Ability. The Neale Analysis of Reading Ability (R-British; Neale, 1989) is both a standardized reading test and a diagnostic test. It can be used to measure the reading ability of most children between the ages of 6 and 12. The Neale Analysis consists of three forms. Two are parallel-standardized tests (Form 1 and Form 2) of six graded passages, and the third form is the Diagnostic Tutor Form, which also has six graded passages and an extension for more advanced readers. The parallel standardized tests allow the teacher to carry out a miscue analysis and monitor children's performance without their becoming familiar with the passages. Each passage is a complete narrative written according to the interests and age level to which it is assigned.

The Diagnostic Tutor Form enables miscue analysis and both criterion-referenced and diagnostic assessments to be undertaken. There are four comprehension questions for the first passage in each form, and eight comprehension questions for the subsequent graded passages. Unlike Forms 1 and 2, the Diagnostic Tutor Form is not supplied with norms (Neale, 1989). Therefore, Form 1 was used in the current study in order to grade the students' reading ability.

The Neale Analysis Manual (Neale, 1989) reports three main types of reliability measure for the test: stability (parallel forms) reliability, internal consistency, and standard error of measurement of the test. The correlation coefficient between the parallel Forms 1 and 2 suggests high stability, between 0.67 and 0.97 at all age levels. The results for Comprehension Reading Age, at all age levels, suggest high levels, between 0.90–0.93, and lower levels, between 0.81–0.87, for the Accuracy Reading of internal consistency for both forms. In the standard error of measurement, the reliability coefficient is very high for the aspects of Accuracy (5.37 and 5.36) and Comprehension (2.98 and 2.87), and high in the Rate (13.73 and 13.2). However, the original edition of the test (Neale, 1958) has been correlated significantly with a number of well-standardized reading scales (e.g., Ballard One-Minute Test, the Holborn Reading Scale, Vernon Word Reading Tests, Burt Spelling Test, Schonell English Usage and Vocabulary Tests, Peel English tests, Kelvin Measurement of Reading Ability, the Junior Simplex Intelligence Scale, and Sleight Non-Verbal Intelligence Test) and shows high intercorrelations, providing evidence for the construct-related validity of the test. The predictive validity of the same edition has been thoroughly investigated.

Dynamic Assessment (DA): The mathematics achievement test. Dynamic assessment (DA) is an interactive approach to conducting assessments within the gifted and/or special education domain that focuses on the ability of the learner to respond to intervention. One of the main purposes of DA is to determine whether students who exhibit achievement deficits have cognitive strengths that are not readily observed (Brown & Ferrara, 1986).

Procedure

A pretest-intervene-posttest method was used to determine whether students who exhibit performance deficits in mathematics have cognitive strengths that are not readily observed. This particular method of assessment comprises two parts: in the first part, a typically devised test is applied to the child under study, and in the second part, a parallel form is applied to the same child after providing him or her with particular teaching in the area of skills and problem solving relating to what he or she has experienced in the pretraining test.

In the current study, the mathematical pre- and posttests were derived from items in the Standardised National Curriculum Mathematics Test, which is administered to Years 4–7 at the national level in the UK. These tests were designed to identify mathematically gifted students. Information about their reliability and validity is unavailable. In the pre- and posttests, all of the students were given five mathematical tasks presented in the same order. The tasks, in order of presentation, included: (a) calculation operations, (b) problem solving, (c) time calculations, (d) geometry, and (e) linear equations.

Calculation operations of number facts were given first so that students' selection of strategies would not be biased by subsequent tasks. The order of the remaining tasks was selected to provide variety and to sustain students' interest. These tasks were difficult enough to provide opportunities for the most able students to show what they could do. Eight students from classes in Years 4–6 were nominated by their head teachers and were given different versions of mathematical pre- and posttests. The questions were read orally to all students. They were told that the problems were challenging and that they should not worry if they found some of them difficult to solve. Because the use of calculators is not allowed in the Standardised National Curriculum Mathematics Test for Years 4–6, no calculators were provided for the students.

Individual teaching related to the nature of the challenging problems in the pretest was provided for all nominated students. The teaching stage lasted approximately 90 minutes (45 minutes for each session with a break of 30 minutes) and was aimed at teaching effective strategies for problem solving and providing the subjects with immediate feedback on their solution strategies. A correct answer was rewarded with positive feedback. When an answer was wrong, the subject received additional mediation until the correct answer was achieved. In order to verify a true comprehension of the mathematical problems, the subjects were asked to explain their methods for solving problems. Questions were also asked in those cases in which the subject had given a wrong answer. The period of the teaching stage was approximately the same for all subjects, with variations of 5 to 7 minutes. Whereas James, Maria, and Anne[1] received 90 minutes of teaching, Richard and William were able to understand the mathematical concepts in 85 and 83 minutes, respectively. The major means of judging the students' mathematical giftedness was the observation of their learning progress and gained scores, as evidenced by the results of the mathematical posttest.

Results

The results of the standardized test scores used to identify and characterize the subjects of the study are listed in Table 1. Both the standardized test results and the information obtained from dynamic assessment involving mathematics tests, as well as interviews, are stated in the case study histories.

Data Analysis

The findings in Table 1 reveal a significant (VIQ-PIQ) discrepancy of 25 points, with verbal scores higher for the five cases of the present study. Anne was the only student who showed no significant discrepancy between the two subscales, whereas William's subscale scores showed a discrepancy of 44 points. His scores in the VIQ and PIQ subscales made it seem as if two different students had taken the test: one average and one gifted. The findings support the argument that the traditional use of a 15-point (at the .01 level) or an 11-point (at the .05 level) discrepancy between Verbal and Performance IQ scores could be a helpful, but inadequate, indicator of the coexistence of learning difficulties and mathematical giftedness (Al-Hroub, 2005). Information about familial, medical, psychological, and educational

1 All names used are pseudonyms.

Table 1

Scores of the Five Case Studies in the Standardized Tests

Standardized Tests		Case 1: James	Case 2: Maria	Case 3: William	Case 4: Richard	Case 5: Anne
WISC-III^{UK} *	Full Scale IQ	138	126	124	119	122
	Verbal Scale IQ	147	131	140	130	120
	Performance Scale IQ	119	110	96	99	119
Neale Analysis	Chronological Age	09:07	09:01	11:05	10:00	10:00
	Reading Rate Age	08:11	09:11	13:00+	10:05	09:11
	Accuracy Age	12:06	08:07	13:00+	13:00	13:00
	Comprehension Age	13:00+	10:02	13:00+	08:05	11:01
Dyslexia Screening Test (DST) **	Rapid Naming	+	-	+	+	0
	Bead Threading	+	0	-	0	+
	One-Minute Reading	0	0	+	+	0
	Postural Stability	-	-	- -	-	0
	Phonetic Segment	0	+	+	+	0
	Two-Minute Spelling	-	- -	0	0	+
	Backwards Span	+	+	+	+	+
	Nonsense Passage	+	+	+	+	+
	One-Minute Writing	-	- - -	- - -	-	+
	Verbal Fluency	+	+	0	+	0
	Semantic Fluency	+	0	+	0	+

* WISC-III^{UK} IQ scores 90–109 = Average, 110–119 = High average, 120–129 = Superior, 130 and above = Very Superior. ** Dyslexia Screening Test: the corresponding index: - - - very severe, - - severe, - noticeable difficulty, 0 average, + strong ability.

histories of the subjects was presented to assist in analyzing and interpreting the findings of the scales' scores.

Case study 1: James. At the time of the study, James was 9 years and 7 months old and in a Year 4 class. His parents separated in 2001. James lived at home with his mother and brother in a socioeconomically advantaged area. He saw his father once or twice a week. His mother was an image consultant and make-up artist; his father a consulting pediatrician. His only brother, who was in Year 6, had been evaluated by a private psychologist as dyslexic, dyspraxic, and suffering from Asperger's syndrome.

James attended a problem-solving workshop in mathematics and received regular teaching in the other subjects in a state school setting.

James attended a nursery school, but since that time had not received any special services related to LDs at school. James was described by his teacher as "very able in mathematics, good at science and history." He was taught by the Year 5/6 class teacher for accelerated mathematics programming at school. His artwork was "very detailed," and he had recently "written detailed stories on the computer at home." On the other hand, the teacher reported that James "has dyslexic tendencies when spelling."

James obtained a Full Scale IQ of 138 on the WISC-III^{UK}. This score indicates that he was a "very superior" student. The test showed a discrepancy between the two scales of the test (Verbal IQ 147, Performance IQ 119). What was glaringly apparent was that James's Coding subtest raw score was 31, well below what would be expected for his chronological age of 9 years and 7 months, although he scored high on all other subtests. Coding indicates the speed at which new tasks are learned, visual memory, motor coordination, perception, and persistence. However, the scale indicated that arithmetic was one of James's major strengths.

A dynamic assessment method was used to determine whether James exhibits high performance in mathematics. James was given the Written National Standardized Mathematics Test for Year 4 (1997 version). The test is divided into two parts: Part A (31 questions in 45 minutes) and Part B (15 challenging questions, untimed test). James solved all of the questions correctly in Part A in 20 minutes, and all of the 15 questions in Part B. According to the score interpretation, James's score set him above the level of Year 4 classes in mathematics. On the following day, James was given 1 hour of intensive teaching in geometry at the level of a Year 6/7 child. He was eager to learn new concepts in geometry. He was given tasks to find the angles without using a protractor. Although James grasped the concepts quickly, he found it difficult to memorize some of the given terms. Thus, he was given a paper that explains the angles, together with their names. One day later, James was given a posttest in geometry, using a test devised from the Mathematics National Curriculum for Years 6 and 7. The test has nine varied questions, six of which challenged his high mathematical ability. James finished the test in only 25 minutes. He answered eight of the questions correctly by finding the angles and giving the reasons for his answers. James demonstrated a high ability in reasoning compared to students in his chronological age group. The last question was the only one that he could not answer, and this caused frustration.

James' DST profile indicated a "noticeable difficulty" in the Two-Minute Spelling, Postural Stability, and One-Minute Writing subtests. By contrast, he showed a "strong ability" in terms of manual dexterity (Bead Threading), Rapid Naming, Backward Span, Nonsense Passage Reading, Verbal Fluency, and Semantic Fluency, together with an "average ability" in the One-Minute Reading and Phonetic Segment subtests. All the "noticeable difficulties" in balance, spelling, and writing appeared to be consistent with James's below-average score in the Coding in the WISC-III^{UK}, which involves speed and motor coordination skills. In the spelling test, James wrote the words "tommorow" instead of "tomorrow," "tong" for "tongue," "foran" for "foreign," and "whos" for "whose."

James showed a positive attitude towards reading. However, his performance in the Neale Analysis indicated a discrepancy between the Accuracy and Comprehension Reading Age (12 years and 6 months to 13 years), and the Rate Reading Age (8 years and 11 months). This revealed that he should be given adequate time to read and comprehend the passages accurately in class. James was a fluent reader, but he made more errors when given timed reading passages. Analysis of his errors revealed that he omitted and mispronounced some words. Analyses of his writing assignments revealed the almost illegible handwriting and poor spelling that frequently accompany a learning difficulty.

There was no doubt that James was mathematically gifted. Although he used written language well, his poor fine motor skills and spelling difficulty affected his performance in written tasks. His high intellectual and mathematical abilities, as well as his spelling and writing difficulties, were obvious to his parents and school.

Case Study 2: Maria. Maria was 9 years and 1 month old and lived at home with her English mother and Chinese father. English was the language spoken at home. Maria was fluent in English, but she did not speak Mandarin. Her father was born and raised in the United States, and his first language was English; he knew a few words of Mandarin. He was a barrister, engineer, and a mathematically very able person; however, he had difficulty in reading and writing, as did some of his Chinese family members. Maria's mother was a teacher and researcher; she had difficulty in writing and weak fine motor skills, which affected her handwriting. Maria had one sister in the reception class and one brother aged 1 year and 6 months. Both Maria and her mother had unusual pencil grip. According to her mother, Maria had a very good, warm relationship with her father and also with her mother, brother, and sister.

Maria was in Year 4, attended a problem-solving workshop in mathematics, and received regular teaching in the other subjects in a state school setting. She attended nursery school for 2 years before entering kindergarten for 4 months in the U.S., where no formal writing or reading instruction was provided. Because of the parental concern about Maria's spelling, she was identified by the Primary Support Service as a student with writing and spelling difficulties, and she had remedial assistance off and on throughout the year. Maria was described by all sources as "a cooperative and quiet" youngster. Maria was shy when meeting new people. Her mother described Maria as an "above average" student with "emotional tension" and "lack of confidence."

Maria obtained a Full Scale IQ of 126 on the WISC-III^{UK}. This ranked her in the 96th percentile, which falls within the "superior range" of intelligence. The Scale showed a discrepancy between the Verbal and Performance IQ Scales. Her Verbal IQ Scale of 131 was at the 98th percentile, which falls within the "very superior" range, whereas her Performance IQ of 110 was at the 75th percentile, which falls within the "average" range. Like James, Maria scored well below average for Coding, although in all other tests she scored very high. This may be partly explained by Maria's unusual pencil grip.

The Neale Analysis Test showed that, according to Maria's chronological age, her reading age was 2 months below average in rate (speed), and 4 months below average in Accuracy Age, but 1 year and 1 month above in Comprehension Age. Analysis of Maria's reading errors revealed she did not have a strong sense of the sound-symbol relationship. Maria's teacher reported that she "has previously had difficulties when reading, but in the last year has improved dramatically." Analyses of Maria's writing assignments revealed the illegible handwriting, spelling, and mechanical errors (punctuation, capitalization, and apostrophes) that frequently accompany LDs. Maria clearly had gaps in spelling knowledge that needed to be addressed systematically. She also needed rigorous, structured support for writing and to proofread her work for punctuation, apostrophes, and spelling.

The DST indicated "very severe difficulty" with One-Minute Writing and "severe difficulty" with Two-Minute Spelling, together with "noticeable difficulties" with Rapid Naming and Posture Stability. In the Two-Minute Spelling Test, Maria misspelled some basic key words, such as "tomorrow" as "tomorow," "doctor" as "docter," "tongue" as "tung," and "laugh" as "lagh." All these difficulties in writing, spelling, and balance appeared to be consistent with the below-average score for Coding in the WISC-III^{UK}. In contrast, Maria showed a "strong ability" in terms of Phonetic Segment, Nonsense Passage Reading, and Verbal Fluency, together with average performance in dexterity (Bead Threading), One-Minute Reading, and Backward Span. The last subtest appeared to be consistent with the average score for the Auditory Sequential Memory, which was noted in the literacy assessment report.

A dynamic assessment method was used to determine whether Maria exhibited high potential in mathematics. She was given the Written National Standardised Mathematics Test for Year 4 (1999 version) at school. Although she was not able to answer some written questions, her overall test score set her above the level of Year 4 classes in mathematics. One day later, she was given a 1-hour lesson focusing on the problems that she encountered in the pretest, which were problem solving in relation to time, money, and advance operations. It was noticed that throughout the teaching session, Maria preferred to solve the problems mentally without writing down her work.

Despite her high mathematical ability, it was clear that Maria had not been exposed at school to some particular methods for solving the money, time, and division problems. However, Maria started to use these methods and to show her written work on paper. This allowed her to solve mathematical problems much more quickly. Because she answered all of the pretest questions correctly, and showed considerable progress during the teaching lesson, Maria was given, exceptionally, in the second day, a more challenging posttest, which was derived from the Mathematics National Curriculum for Years 4–6 (1999 version). The posttest has eight varied problem-solving questions, five of which are derived from a test designed for a Year 6 class.

Maria answered all of the test questions in 41 minutes. Although Maria needed extra time to solve the given problems, she was able to answer all of the questions correctly.

Maria is an example of a student with severe learning difficulties that affect her performance in all areas and seem to override her high mathematical ability. However, both Maria's parents and the school were aware of her high mathematical ability and her learning difficulty, especially in writing and spelling.

Case study 3: William. At the time of the study, William was 11 years and 5 months old, a Year 6 pupil within a class of very mixed abilities and varied social backgrounds. He received only regular educational teaching in his state school. William was well-spoken, verbally fluent, with a sunny nature, a wonderful sense of humor, and wide-ranging general knowledge. William was the youngest child in his family; he had a 14-year-old brother who was "slightly dyspraxic," had handwriting difficulties, and had been referred to a psychotherapist. William's father was a university lecturer in law and was intelligent and slightly dyspraxic. His mother was a commercial manager. William was previously evaluated by a private psychologist for dyspraxia and had motor problems in writing and in marshalling his thoughts quickly.

William attended a nursery school for 2 years before entering Year 1 at 5 years old. His parents stated that there were no concerns about him as a preschool child. When William was in Year 1, the school identified his high ability; a specialist assessed him and found that he had high ability in language.

William was a top debater, mature, an avid reader, had characteristics of leadership, and had shown a passion and strong aptitude for creative writing, mathematics, and music. He was bright, able to learn at a very fast rate, and needed only to concentrate to grasp new concepts. He was quickly bored by work that was too easy and did not need any of the repetition that is built into the national literacy and numeracy strategies. He experienced a great deal of tension, especially when he felt tired. He shouted, screamed, and threw objects when overstretched. His teacher reported, "In terms of his ability, I feel we have not yet seen just how much William could do if he were not so very anxious about failing." His mother stated that he was suicidal at one point when he lost control following misdiagnosis for ADHD.

A psychiatrist prescribed Ritalin to modify his hyperactive behavior, but in fact, it made him hyperanxious. The disturbed behavior he exhibited while reacting to Ritalin brought him into conflict with his school; he was withdrawn and became depressed, after which he changed schools.

All of the sources stated that William was "a very popular boy in the class and he frequently leads activities both during breaks and during lessons." His teacher reported that he had high mathematical abilities, and exceptionally high ability in language and science. William played the piano for the school assemblies, and had begun peer-tutoring another boy during some lunch times. In contrast, it was reported that William was, however, slow to do his laces up, to put on shoes, to dress, and to organize himself, and he needed to plan sequences of action.

William obtained a Full Scale IQ of 124 on the WISC-III^{UK}. This ranked him at the 95th percentile, which falls within the "superior range" of intelligence. Of particular interest was the 44-point discrepancy between his Verbal and Performance IQ Scales scores. William's Verbal IQ Scale of 140 was at the 99.6th percentile level, which falls within the "very superior range," whereas his Performance IQ of 96 was at the 39th percentile level, which falls within the "average range." His subtest scores in the Verbal and Performance domains appeared as if two different students had taken the test: one average and one gifted. The assessment indicated that the contrast between his superb verbal skills, his weaker coordination, and slower speed of processing of visual skills were highly significant and sufficient to cause him a great deal of frustration in class. Coding was the most significant learning block.

A dynamic assessment method was used to determine whether William exhibited high potential in mathematics. He was given pre- and posttests that were derived from the Written National Standardised Mathematics Test for Year 6 (2000 and 2001 versions). The pretest consisted of 11 questions, 5 of which were challenging mathematical questions in the area of geometry, problem solving, and linear equations. When he was given the pretest, William looked at the questions and without reading any of them, said, "I cannot do it, these are so difficult." The questions were read to him orally, and this encouraged him to begin answering them. He answered eight questions correctly, but could not answer the linear equation question and refused to read or answer the rest as he became tired. It was clear that William tended to answer questions mentally without writing down the method for solving the problems.

A day later, a 1-hour lesson was given to William that focused on advanced geometry and problem-solving questions, which he had found difficult to answer in his pretest. In the one-to-one teaching session, he listened carefully to the teacher and asked several questions about using different methods for solving mathematical problems. Noticeably, individual teaching proved to be a suitable method to use with William in order to attract his attention and maintain his concentration. However, although he showed high mathematical potential, William had not memorized the times table. He showed no desire to write down his answers to the given exercises; he preferred to give his answers orally. The following day, William was given a posttest that focused on problem solving, geometry, and linear equations. To accommodate his short attention span and lack of concentration, William was given a shorter posttest, which consisted of six questions. Like the behavior he had previously displayed when he started to answer the pretest questions, William quickly looked at the posttest questions and said, "I cannot do it . . . I am so tired." However, the questions were read to him orally and this encouraged him to start solving the problems. He answered all of the problem-solving and geometry questions, but he could not solve the linear equation question. He was able to finish in 44 minutes, which could be considered a long time. This suggests that William can master tasks if he is given adequate time.

The DST indicated "very severe difficulty" with One-Minute Writing and "severe difficulty" with Posture Stability, together with "noticeable difficulties" with dexterity (Bead Threading). All of these difficulties in writing, dexterity, and balance appear to be consistent with the below-average Coding in the WISC-III^{UK}. This suggests that William's ability to coordinate actions in order to write at speed was therefore significantly below his chronological age. In contrast, William showed a "strong ability" in terms of Rapid Naming, One-Minute Reading, Phonetic Segment, Backward Span, Nonsense Passage Reading, and Semantic Fluency, with average performance in Two-Minute Spelling and Verbal Fluency. These strengths suggest that the difficulties were largely limited to the phonological domain.

The Neale Analysis Test showed that William's reading age was at least 1 year and a half above his chronological age. William's reading was fluent, fast, and accurate, and his comprehension in the six given passages was at a high level. Analysis of William's reading revealed that he had a strong sense of the sound-symbol relationship, reflecting his exceptional oral language ability. Correspondingly, a private psychologist reported that William's reading age in the Wechsler Objective Reading Dimensions (WORD) was 2 years and 7 months above his chronological age.

A comparison of William's IQ (Full Scale, Verbal, and Performance) scores, his mathematics Dynamic Assessment, school academic achievement, and his daily performance in academic tasks indicated that his writing and handwriting difficulties and high mathematical ability were masking each other.

Case study 4: Richard. Richard was a 10-year-old, Year 5 pupil receiving regular educational teaching within a large class of Years 5 and 6 children of very mixed abilities and varied social backgrounds. Richard lived at home with his parents and brother in a socioeconomically advantaged area. Richard was a quiet and reserved child in the classroom. His father was a managing director and his mother a director. Richard's father claimed to be like Richard; he thought more quickly than he wrote, so his secretary was constantly correcting his grammatical mistakes in English.

Richard attended a nursery school 2 years before entering Year 1 at 4 years and 4 months old. Richard was not easy to get along with; he did not initiate conversations with teachers and new people, although he was an independent child. His teacher related that he was "difficult to motivate, hates anyone to do better than him."

Richard's major strengths were mathematics and gymnastics. He described his favorite subject by saying, "I like mathematics, but I do not like writing." His score in the National Mathematics Test set him above average in relation to his chronological age. According to his parents, he is an "above average student." Richard's teacher noted that he "irritates anyone not as quick as him; rather scornful with children with difficulties."

Richard obtained a Full Scale IQ of 119 on the WISC-III^{UK}. This ranked him at the 82nd percentile, which falls within the "above average range" of intelligence. The Scale showed a discrepancy between the Verbal and Performance IQ Scales. His Verbal IQ Scale of 131 was at the 98th percentile, which fell within the "very superior range," whereas his Performance IQ of 99 was at the 47th percentile, which fell within the "average range" for his age. His performance in the Object Assembly subtest, which assessed his visual sequencing and spatial skills, was below average for his age, reflecting a difficulty with speed of working rather than inaccuracy. The Coding subtest assessed his ability to scan, match, and copy shapes at speed and to respond by writing. In this test, his performance was below the expected level for his age. According to Richard's teacher, he had difficulty in writing, and he often wrote illegibly. Although his writing had improved enormously over the past year, he hated writing. An observation of the student showed that he had some difficulty in grasping his pencil and in writing. The contrast between his superb verbal skills, his weaker coordination, and slower speed of processing visual material was significant and caused him a great deal of frustration in class.

A dynamic assessment method was used to determine whether Richard exhibited high performance in mathematics. Although Richard was in Year 5, he was given pre- and posttests that were derived from the Written National Standardised Mathematics Test for Year 6 (2000 and 2001 versions) at school. The pretest consists of 11 questions, 5 of which would challenge his mathematical abilities in the areas of geometry, problem solving, and linear equations. The questions were read to him orally. In 35 minutes, Richard answered seven questions correctly, but could not answer the linear equation and one of the problem-solving questions. Richard indicated that he had never been given such difficult questions to solve in his class, and admitted that he "guessed some of the answers."

On the following day, Richard was given a 1-hour lesson focusing on the advanced exercises in relation to linear equations, geometry, and the problem-solving questions that he found difficult to solve. Richard displayed a high potential for understanding new mathematical concepts, and it was only on one occasion that he asked for the explanation of the method for solving a particular problem to be repeated. He was enthusiastic, motivated, and pleased about the praise he received. It was obvious that such individual teaching was an appropriate method, especially to help him solve advanced mathematical problems. One day later, Richard was given a posttest of six questions that consisted of problem solving, geometry, and linear equations. Richard answered all of the questions correctly in 35 minutes, which can be considered an average amount of time. This suggests that Richard can solve and master advanced mathematical tasks if he is exposed to them in the regular classroom.

The DST indicated "noticeable difficulties" with Posture Stability and One-Minute Writing. These difficulties in writing and balance appeared to be consistent with the below-average score for the Coding and Object Assembly subtests in the WISC-III^{UK}. This suggests that Richard's ability to coordinate actions, to use visual sequencing and spatial skills, and to write at speed were below average for his chronological age, reflecting a difficulty with speed of working rather than inaccuracy. His parents commented, "When we encourage him to write sometimes, he can do it easily." In contrast, Richard showed a "strong ability" in terms of Rapid Naming, One-Minute Reading, Phonetic Segment, Backward Span, Nonsense Passage Reading, and Verbal Fluency, with "average ability" in dexterity (Bead Threading). In the Two-Minute Spelling Test, although Richard misspelled some basic key words, such as "laugh" as "lagh," "doctor" as "docter," and "tongue" as "tongque," his spelling score indicated that he was average according to his age. All of the abovementioned strengths in the DST suggest that the difficulties were largely limited to the phonological or the oral language domains. Analyses of Richard's writing assignments revealed that he had illegible handwriting and made mechanical errors, such as punctuation, capitalization, and omission of some letters.

The Neale Analysis Test showed that Richard's reading rate age was 5 months above his chronological age. Although Richard showed fluent and accurate reading, his comprehension age was 1 year 7 months below his chronological age. Analysis of Richard's reading revealed that he had a strong sense of the sound-symbol relationship and mispronounced few words, which reflected his high oral language ability. His teacher reported that "he uses all strategies to tackle unfamiliar words, and needs a little help to be independent."

Richard's case exemplifies the need for informal as well as formal assessment data in identifying dual exceptional children. His test scores indicated high intellectual and mathematical abilities. Lacking historical data, one could easily overlook his LDs in writing.

Case study 5: Anne. Anne was a 10-year-old, Year 5 pupil receiving regular educational teaching within a large class of Years 5 and 6 children of very mixed abilities and varied social backgrounds. Anne lived at home with her mother, father, and brother. Anne was a friendly, cheerful, cooperative, and polite girl. Anne's teacher stated that she was very peaceful and calm, but did not have close relationships with other students. Anne's father was a sales manager, and her mother was a dental nurse and laboratory technician. Anne's mother was Polish, but English was the language spoken at home. Accordingly, Anne's first language was English and she also knew some German words. Anne was left-handed and had an unusual pencil grip. Both her mother and brother were right-handed and her father was ambidextrous. A hearing support report indicated that Anne had a mild bi-lateral hearing loss perhaps explaining her lisp. This ear infection, which happened only in the winter months, caused her some difficulty in understanding what was being said, particularly if there was significant background noise. Anne did not attend a nursery school. She entered her first year when she was 4 years old, and transferred to another school when she was in Year 3. Her Year 1 teacher reported that she could listen to instructions and follow them, but needed to pay more attention at times and try not to interrupt.

Anne's teacher reported she had "high abilities in mathematics." The Written National Standardised Mathematics Test indicated that she was an above-average student in mathematics. Anne's special interest was lace-making and embroidery. She had very good gross motor skills. In contrast, Anne's teacher emphasizes that she had some language "gaps." She sometimes did not understand anything except literal language. Anne was described as sometimes being tense and irritable, speaking crossly, and unable to understand other children. Her mother emphasized that English was Anne's first language. She mentioned that Anne could speak very few words of German and Polish and thus she would not consider her a bilingual student.

During the testing session, Anne was cooperative and generally followed directions well. Anne obtained a Full Scale IQ of 122 on the WISC-III^{UK}. This ranked her at the 93rd percentile, which falls within "the superior range" of intellectual functioning. The Scale showed no discrepancy between the Verbal and Performance IQ

Scales. Her Verbal IQ Scale of 120 was at the 91st percentile, whereas her Performance IQ of 119 was at the 90th percentile.

A dynamic assessment method was used to determine whether Anne exhibited high performance in mathematics. Although Anne was in a Year 5 class, she was given pre- and posttests derived from the Written National Standardised Mathematics Test for Year 6 (2000 and 2001 versions). The pretest consists of 11 questions, 5 of which would challenge her mathematically in the areas of geometry, problem solving, and linear equations. Anne finished answering the test in 35 minutes; although she answered six questions correctly, she could not answer the linear equation and geometry questions and one of the problem-solving questions. According to Anne, she had never received lessons in geometry or linear equations in her regular classroom. On the following day, Anne received a one-to-one session lasting 1 hour that focused on advanced exercises on linear equations, geometry, and problem solving. Anne was enthusiastic, cooperative, and motivated during the teaching session. She displayed high mathematical abilities, especially in geometry. It was obvious that individual teaching was a more suitable approach to be used with Anne as she became noticeably more confident in asking about the most appropriate methods to use in solving the problems. One day later, Anne was given a posttest that included six questions relating to problem solving, geometry, and linear equations. In 25 minutes, she answered five questions correctly. In the linear equation question, she used the right method for solving the problem; however, because she forgot to write a negative sign (-), her final answer was wrong. This suggests that Anne can master advanced mathematical tasks, especially the visual ones, if exposed to them in the classroom.

The Neale Analysis Test indicated that Anne's reading rate age was average according to her chronological age. The test indicated strengths in terms of reading accuracy and reading comprehension. Her reading accuracy was 3 years above her chronological age and her reading comprehension was 1 year 1 month above. Analysis of Anne's reading revealed that she had a strong sense of the sound-symbol relationship and few mispronounced words, which reflected her high oral language ability. Anne's teacher stated that she was a "good and fluent reader." The DST indicated a "strong ability" in terms of dexterity (Bead Threading), Two-Minute Spelling, Backward Span, Nonsense

Passage Reading, One-Minute Writing, and Semantic Fluency. The test also revealed an "average ability" in Rapid Naming, One-Minute Reading, Postural Stability, Phonetic Segment, and Verbal Fluency. However, analyses of Anne's writing assignments revealed that she wrote neatly with well-formed and "big" letters, but had a noticeable difficulty in composition and expressive written language. Although she took extra time in class, Anne found it difficult to organize the structure of her ideas into a coherent form to make a story.

Anne's case demonstrates that her intellectual and mathematical abilities and expressive written difficulty mask each other, given that her mother reported that she was an "average" student. Moreover, Anne's English language is outstanding in other aspects, such as reading comprehension and spelling, given that spelling needs an accurate hearing capacity. On the other hand, reading comprehension and expressive writing are not dependent on this capacity.

Discussion

Conclusions

The findings of the current study support several conclusions. First, the assessment profiles and case histories developed for each subject represent the whole picture of the educational, familial, medical, and psychological backgrounds. Second, a multidimensional assessment provides a more accurate and sensitive means of identifying gifted children with LDs. Third, a distinctive cognitive pattern and verbal-performance discrepancies provide good indications to enable identification of the subjects. This finding supports several assertions that a significant discrepancy in VIQ-PIQ may be one of the cognitive characteristics of gifted children with LDs (Kaufman, 1994; Silverman, 1983). This is also consistent with the assertion that the traditional use of an 11-point discrepancy (at the .05 level) may be a helpful, but inadequate, indicator of the coexistence of mathematical giftedness and LDs (Al-Hroub, 2005). Nevertheless, this discrepancy should be interpreted cautiously. According to Kauffman (1994), most children with LDs, and many with no LDs, exhibit a discrepancy between the Verbal and

Performance IQ scores. Also, discrepancy is considered to be typical for children with autism, language problems, and emotional disorders.

Fourth, the psychometric test scores listed in Table 1 present only a partial picture of students with LDs, but they enable teachers, educators, and counselors to improve the individual education plans, and develop more appropriate teaching strategies. For example, Maria's and Anne's mothers described their children as nonbilingual and stated that English was their first language. This information was important in understanding that their LDs are not primarily the result of being exposed to other languages. Observation showed that, apart from Richard, all of the students have an unusual pencil grip, suggesting weak fine motor skills, which is considered to be one of the symptoms of students with LDs (Thomson, 2001). Previous psychoeducational and school reports supported the existence of LDs in James and William. Richard's father acknowledged after his son was assessed, that he is, like Richard, suffering from LDs. This information was also helpful for his teacher to understand Richard's case. Fifth, dynamic assessment involving a mathematics test provides a means for assessing the untapped mathematical potential development of the participants (Brown & Ferrara, 1986). It also provides a domain-specific diagnosis of children with LDs and information on how mathematically gifted children attempt to perform tasks. It was developed to overcome the shortcomings of psychological tests. Therefore, it may be considered a complementary approach that strengthens the findings of the psychological assessment.

Sixth, historical data, a student's school records, psychological reports, teacher and parent interviews, and task analysis of the student's paperwork not only provide supplementary information, but also clarify the quantitative data about the subjects. Seventh, according to Baum (1989) and Brody and Mills (1997), these students are classified into three unequally sized subgroups, as follows: (a) gifted students who have unrecognized learning difficulties; (b) students with recognized learning difficulties, but unrecognized giftedness; and (c) students with unrecognized giftedness and learning difficulties. Richard and Anne were described by their parents and schools as gifted students with no real LDs (the first group). No students in the cases that have been studied were described as having LDs and not being mathematically gifted (the second group). It may be noted that the lack of recognition of the second group is not surprising as no systematic school-wide testing had been conducted. William's high mathematical ability and writing difficulties mask each other (the third group). However, James and Maria were described at school as students with high mathematical abilities who show evidence of specific LDs, which is not a category that has been previously recognized by Baum's (1989) or Brody and Mills's (1997) classification. These results may imply the existence of a fourth subgroup, which is visible to some teachers and parents, who are left with no rigorous guidance as to how to serve these students.

As all of the subgroups are variable rather than permanent, their size is unequal and could always change. To conclude, there are strong indications that cooperation and partnership between parents, teachers, and the inspector of gifted education have played a major role in recognizing the subjects of the present study. For example, James and Maria were recognized by a teacher who has more than 40 years' teaching experience. Strong partnerships were also reported between this teacher and all other parents. Therefore, providing in-service training for teachers, the school community, and parents would raise their awareness of the definitions, identification, and characteristics of dual-exceptional students. Nevertheless, teachers' training would increase the number of referrals of this population to special education and narrow down the other three subgroups in favor of this fourth one.

However, the main recommendation suggests that students with both mathematical giftedness and LDs need to have their own unique learning differences recognized. As a result, successful enrichment and remediation (Brody & Mills, 2004) should be provided. In considering the most appropriate forms of provision for mathematically gifted students, it is important to bear in mind the nature of the mathematical abilities we should be trying to develop. Mathematically gifted and LD students require some differentiated assessment, instruction, and curriculum.

Research Implications

Four kinds of theoretical and practical implications may be drawn from the current study. First, the present study may be considered to be a step toward the development of a theoretical framework for gifted children with LDs. Many potentially answerable questions about this population of students remain unexplored. For example, the findings were not able to answer the question: Do those students tend to have any special emotional or behavioral issues? The small number of subjects does not allow the researcher to generalize common characteristics for those students. Furthermore, there is little consensus between educators, especially from different cultures, about what is meant by giftedness and LDs. However, the findings displayed the necessity for provision of special educational services for able students in mathematics who have LDs. These special services should be determined according to the individual needs by designing a special approach to teaching.

Second, practical implications may be drawn from the current study in certain areas, such as the use of operational definitions of the gifted with LDs, the number of participants, and the duration of the assessment process, using a multidisciplinary team of psychologists and consultants to assess these students. Third, in order to accurately identify more gifted students with LDs, teachers, gifted specialists, LD specialists, and school psychologists need to be trained to look less at the large-scale scores and gross indicators and to focus more on the patterns of scores that reflect the unique cognitive and academic processing qualities that differentiate gifted students with LDs from those identified as gifted or dyslexic. Fourth, comprehensive psychodynamic educational assessments can identify unexpected areas of giftedness and LDs. Therefore, a variety of assessment tools and strategies could be used to gather relevant information about dual-exceptional students.

The multiple criteria of assessment instruments give a more complete picture of the student's cognitive abilities and difficulties (Lazarus, 1989). Dynamic assessment gives the student the opportunity to transfer newly acquired skills to similar situations (Brown & Ferrara, 1986; Kirschenbaum, 1998). Therefore, dynamic assessment should be carried out in all of the curriculum subjects by the regular-class teacher and/or the gifted/LD service teacher.

One could question whether the study findings were really able to answer the central research question with such a small sample. It is important to note that in research studies, externally validated results are primarily supported by the extent to which these results are *generalizable* or *transferable*. Although most initial discussions of external validity focus solely on generalizability (see Campbell & Stanley, 1966), some researchers, such as Denzin and Lincoln (2005), have included a reference to transferability because many qualitative research studies, such as the current one, are not designed to be generalized. In other words, the study's findings invite readers, for example, to make connections between the multiple-dimensional approaches to identification using their own educational experiences.

There are many students who exhibit high mathematical ability and yet have difficulty mastering basic academic skills, including mathematical skills, and thus may need special programming. To understand this population of students, there is a need to avoid using rigid definitions and cut-off scores to determine who should receive special services. In addition, findings demonstrate the pressing need for further research that takes into account a larger number of students, and for a team of multidisciplinary assessors. Further research should explore other areas of giftedness beside mathematics, such as art, music, or leadership. Multidisciplinary assessment would be the best approach to identifying students who have different abilities.

Research Limitations

A number of limitations relate to several primary areas. One area that some critics may consider a limitation concerns the restricted period of time, which was 3 months. Accordingly, the presented data could be considered as a snapshot of these children over a relatively short period of their schooling, and the opportunity to work with them over a longer period might well have provided further insights. In addition, the small sample of the research should not be seen as a representative of the population of mathematically gifted students with LDs. A further limitation is related to the narrow scope of the study whereby data were gathered from 3-year levels (Years 4 to 6) at three schools in Cambridgeshire, England. Although all of these grades are considered crucial in a child's academic career, a study emphasizing a broader scope that encompasses students in other grades might more effectively reveal key cognitive characteristics of mathematically gifted children with LDs. Moreover, the researcher was the sole diagnostician for all cases of the study. Although he is a specialist in mathematical giftedness and dyslexia, a multidisciplinary team of psychologists and specialists is also needed for more triangulated and reliable findings. Another limitation concerns the way in which the order of psychometric and dynamic assessment was administered. In the first step of assessment, one has to verify the presence of high intellectual and mathematical giftedness. Therefore, it would be more appropriate to assess students first by using the WISC-III^{UK} and then moving on to the dynamic assessment that involves a mathematics test. In the second step, students should be assessed by means of tests that determine their levels of learning ability, such as the Dyslexia Screening Test and the Neale Analysis of Reading Ability. Finally, the use of different dynamic assessment materials at different grade levels has some implications for validity, particularly for those learners whose pre- and posttests covered different grade levels. However, one can argue that learners also have different levels of mathematical giftedness and all questions were derived from standardized mathematics tests at Key Stages 2 and 3, which were originally designed (Part C of the tests) to challenge more able children in mathematics at British schools.

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