Psychometric versus Dynamic Assessment for Mathematically Gifted Children with Learning Difficulties

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Abstract

The purpose of this research is to investigate the efficacy of psychometric and dynamic assessment to identifying 'mathematically gifted students with learning difficulties' (MG/LD) in Jordan. An extensive process of quantitative methods was conducted by a multi-disciplinary team to identify a sample of 30 students (16 girls and 14 boys) in the fifth and sixth grades, ages 10 years to 11 years and 11 months, at three public primary schools in Amman, Jordan. A multi-dimensional evaluation involving a combination of psychometric (i.e. WISC-III-Jordan, Perceptual Skills Tests, and a diagnostic Arabic Literacy Language Skills) and dynamic mathematics assessment was used. The findings of the WISC-III-Jordan test revealed a significant verbal-performance discrepancy, in addition to the characteristic patterns of strengths and weaknesses in the subtests profile and factors of five cognitive classification systems and models. The findings of the dynamic mathematics assessment showed that 90.4% of the students who scored 120 or above on the WISC-III-Jordan (30 out of 32) showed a high variance of performance (35.4%) between the pre- and post-tests. Visual perceptual skills, including visual short-term memory, were found to be significantly stronger than auditory perceptual skills in the MG/LD sample.

Psychometric Assessment versus Dynamic Assessment

There is an important relationship between psychological assessment and what happens subsequently regarding the child's learning. The individual educational plan is attempting to discover the ways in which the assessment can inform the next steps of the child's learning. Conventionally, researches have been concerned with psychometric tests such as the WISC-III, dyslexia tests, and achievement tests. Such tests have been used in the researches as bases for assessing intellectual giftedness and learning difficulties, but have focused primarily on technical issues, for example, standardisation and reliability and, therefore, a lot of other important issues have been neglected; for example how can the student's learning be improved? Are timed tests suitable to be used with students with learning difficulties who need extra time to read and comprehend the questions?

Also, when using psychometric tests, certain procedures are followed, and specific tasks are given. The students must remain passive, and are not able to make their own contribution to the assessment process. Accordingly, the empowering function of this assessment may not be considered sufficient by educational psychologists. Psychometric tests have received further criticism for being unfair to ethnic minorities and children from disadvantaged backgrounds (Kaufman, 1990; Satler, 1992). Further criticism could be made of the tendency of psychometric test performance to be used as representative of overall ability when only a fraction of the child's intelligence has been tested. This can have serious consequences for a student and lead to negative labels being attached to students in the basis of their performance on psychometric tests (Lauchlan & Elliott, 2001).

Contemporary researchers have suggested assessing the potential development of gifted children with learning difficulties using the concept of dynamic assessment. This untraditional approach to assessment is predicated on the belief that one can learn more from a child's cognitive development by working with the student, together, as opposed to assessing their unassisted performance. Rutland and Campbell (1995) argue that assessing the potential development of children with learning difficulties using the concept of dynamic assessment methods allows one to escape from the depressing view that these students will always have a general cognitive deficit as identified by IQ tests.

This movement away from static towards dynamic assessments of giftedness was partly initiated in the 1920s by the work of Vygotsky (in Wertsch, 2004) on the Zone of Proximal Development (ZPD). The idea is that with specific provision (scaffolding) and mediation (adult guidance, especially through language) children can learn at a far greater speed than otherwise. For young children, Vygotsky pointed to guided play as a rich context for the development of the ZPD in exploring new knowledge and ideas. The Dynamic Theory of Giftedness (DTG) is based on Vygotsky's developmental concepts of 'plus- and minus-giftedness' (Vygotsky, 1983). This uses the dynamic paradigm that either giftedness or defectiveness is possible outcomes when a child is faced with barriers to development. The dynamic assessment approach can provide a means for assessing disadvantaged, disabled, and underserved gifted and talented students. It also provides a domain-specific diagnosis of children with learning difficulties. This allows the examiner to focus on the particular problem that each child has in a specific domain (Kirschenbaum, 1998). Bolig and Day (1993) present five reasons why dynamic assessment can be useful in identifying gifted and talented: (1) it can detect differences in learning ability among students with identical intelligence test scores, (2) it provides information that helps determine how and what to teach individual students, (3) it was developed to overcome shortcomings of traditional tests with respect to their use with disadvantaged students, (4) its focus is on learning ability more than knowledge, (5) it provides information on how students attempt to solve tasks; therefore, it sees students' errors as signs of mistaken beliefs, gaps in knowledge, selection of incorrect strategies, and cognitive deficiencies. However, dynamic assessment is not claimed to be an alternative to the static psychometric approach. It is a complementary approach that can strengthen the findings of the multidisciplinary assessment about gifted children with learning disabilities.

Specific questions guided this study to identifying mathematically gifted students who have learning difficulties, as follows: (1) What are the characteristics pattern of strengths and weaknesses that these students tend to yield on the Wechsler Intelligence Scale for Children (WISC-III-Jordan)?, (2) To what extent does the use of dynamic assessment address the mathematical gifted abilities of children experiencing difficulties with learning?, (3) What are the specific perceptual skills that these students tend to have?; and (4) What are the patterns and levels of learning difficulties that the MG/LD students displayed?

Method

Subjects

As multiple case studies, a multi-disciplinary team identified 30 students, 14 boys and 16 girls, ages 10 years to 11 years and 11 months from Grades 5 and 6 at three public primary schools in the capital of Jordan, Amman. The subjects were chosen from Grades 5 and 6 to avoid earlier years, as students who have specific learning difficulties or high ability in mathematics are difficult to recognise or identify in the earlier years of schooling. All of the students were from relatively advantaged backgrounds, and Arabic was the first and spoken language at home. In the process of selecting the 30 cases, 52 students were nominated by their classroom teachers and evaluated in the study; 22 students were excluded from the research as they did not fit the study sample.

Procedures

Combinations of techniques of identification were used, whereby some were used to identify the giftedness, while others were used to identify learning difficulties. The assessment strategies in the present study that were used to identify the subjects were carried out by a multi-disciplinary evaluation team. This team consisted of the a group of two professionals as follows: (1) a psychologist who used his expertise in the fields of psychology and special education to administer the WISC-III-Jordan and dynamic mathematics tests; and (2) a learning difficulties diagnostician who has wide experience of evaluating students with learning difficulties in Jordan. The team evaluated each student for approximately 12-15 hours over 7-9 sessions. Most of the assessment sessions were carried out in the counsellors' rooms and, if not, in a learning resource room or the library. The multi-disciplinary team conducted the following four tests: (1) The Wechsler Intelligence Scale for Children (WISC-III Jordan, 1996), (2) Dynamic Assessment involving a mathematics achievement test, (3) The Group of Perceptual Skills Tests (Waqfi & Kilani, 1998); and (8) The Diagnostic Scale of Arabic Language Basic Skills (Waqfi, 1997a)

The Wechsler Intelligence Scale for Children (WISC-III-Jordan, 1996)

The WISC-III-Jordan (1996) is an individually administered clinical instrument for assessing the intellectual ability of children and young people aged from 6 years, 0 months through to 16 years, 11 months. This age group fits the ages of my study's subjects. The WISC-III Jordan assesses, in 50-70 minutes, general intellectual functioning by sampling performance in many different types of activities. This scale consists of 13 subtests grouped into two scales: Verbal, six subtests, and Performance, six subtests. The WISC-III-Jordan scores yield an overall intelligence quotient called the full scale IQ, as well as a verbal IQ and a performance IQ. In research studies of the gifted it is usual to confine the 'gifted' sample to those who have at least one IQ score at 130 or above (Montgomery, 1996). Silverman (1989) suggested the level for inclusion in these gifted education programmes should be dropped by ten points in the case of those with a learning difficulty. Accordingly, students in this research who scored 120 or above on the full IQ scale were labelled 'gifted'.

Dynamic Assessment (DA): the mathematics achievement test

A pre-test – intervene - post-test 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 typical devised test is applied to the child under study, and in part two an identical test is applied to the same child after providing him/her with particular teaching in skills and problem-solving relating to what the child has experienced in the pre-training test. Before conducting the DA in this research, pilot-test sessions were used with eight mathematically gifted students who were chosen by their mathematics teachers (four girls and four boys; four Grade 5 and four Grade 6) and according to their academic superiority in mathematics at schools. These pilot test sessions where conducted to modify the questions and estimate the required time for solving the problem, which lasted approximately 45 minutes. However, the DA test was derived from items in the Diagnostic Scale of Mathematical Basic Skills (Waqfi, 1997b), which is applied to students from 1st to 9th grades at the national level in Jordan. In part one of the test, I applied a previous version or a devised test from the Mathematical Basic Skills Scale. The mathematical areas that the test covered were: (a) calculation operations, (b) ordering of decimals, (c) rounding up, (d) geometry, (e) algebra and (f) problem-solving. Then I undertook particular teaching that related to the nature of the problems that they faced in the test. In part three of the DA procedure, the post-teaching stage, another devised test was used to assess the same areas that were covered in the pre-teaching test. I read the questions and tasks to the students and emphasised that the children were free to ask if they did not understand the wording of any of the questions.

The Group of Perceptual Skills Tests (Waqfi & Kilani, 1998)

The Group of Perceptual Skills Tests provides a profile of the strengths and weaknesses that are often associated with learning difficulties of children aged from 6 years, 7 months to 16 years, 6 months. The Perceptual Tests take around 45 minutes overall to administer, which is within the attention span of most children in this age group. The Perceptual Skills Tests battery includes seven diagnostic subtests cover 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 difficulties; these subtests are: (1) Auditory Discrimination Test, (2) Auditory Analysis Skills Test, (3) Word Span Test, (4) Digit Span Test, (5) Visual-Motor Sequence Test, (6) Visual-Motor Integration, and (7) Visual Analysis Skills Test (Waqfi & Kilani, 1998). However, the seven perceptual subtests were categorised into six major perceptual areas (Waqfi & Kilani, 1998), as follows: ***(1) The Auditory Perceptual Skills***, which consists of four subtests: (a) Auditory Discrimination, (b) Auditory Analysis Skills, (c) Auditory Word Span and (d) Auditory Digit Span; ***(2) The Auditory Discrimination and Analysis Skills***, which consists of two subtests: (a) Auditory Discrimination, and (b) Auditory Analysis; ***(3) The Auditory Short-Term Memory***, which consists of two subtests: (a) Auditory Word Span and (b) Auditory Digit Span; ***(4) The Visual Perceptual Skills***, which consists of three subtests: (a) Coding, (b) Visual-Motor Integration and (c) Visual Analysis Skills; ***(5) The Visual Integration and Analysis Skills***, which consists of two subtests: (a) Visual Motor-Integration and (b) Visual Analysis Skills; and ***(6) The Visual Short-Term Memory***, which consists of the Coding subtest.

The Diagnostic Scale of Arabic Language Basic Skills (Waqfi, 1997a)

The Arabic Language Basic Skills Scale is a diagnostic test that covers a comprehensive range of topics in Arabic Language skills. It is designed to test listening comprehension and speaking, reading and writing skills at a basic level of most children between the ages of 6 and 15 years. However, seven subtests were used from this diagnostic test, which allow year-on-year testing as each level spans more than one grade-level grouping. The seven subtests are the following: 1) Vocabulary Recognition, 2) Reading Different Vocabulary, 3) Reading Similar Vocabulary, 4) Reading Comprehension Passages, 5) Listening Comprehension Vocabularies, 6) Listening Comprehension Passages, 7) Spelling Passage and Dictation. These seven subtests were categorised into three learning aspects, which are: ***(1) Reading Ability.*** This contains four subtests, which are: Vocabulary Recognition, Reading Different Vocabulary, Reading Similar Vocabulary and Reading Comprehension Passages, ***(2) Listening Ability.*** This examines the extent to which the student can comprehend information listened to. It contains two subtests, which are: Listening to Different Vocabulary and Listening Comprehension Passages; and ***(3) Spelling and Dictation.*** This area is represented by the graded Spelling and Dictation subtest (Waqfi, 1997a).

Results

This section presents the key findings of the research, which answer, in addition to the discussion section, the general and specific research questions.

Verbal-Performance Discrepancy and the Subtest Profile Scatter

The findings obtained from the scores of the WISC-III-Jordan show that 'mathematically gifted students with learning difficulties' tended to show some similarities and differences in cognitive characteristics that support the findings of previous studies (Baum, 2004; Ruban & Reis, 2005; Stewart, 2003). Table 1 presents the WISC-III-Jordan scatter/range indices for the MG/LD sample and the Average-LD group. The differences for the MG/LD group were compared to the differences for the Average-IQ/LD group. The analysis of the subtest scatter/range indices results indicates that the mean VIQ-PIQ discrepancy of 12.73 points for the MG/LD sample is more than one and a half times the value of 7.95 points for Average-LD students, but it is not significantly greater than the Average-LD mean [t (50) = 1.72, p = .092].

Table 1 Comparisons between WISC-III-Jordan Scatter Indices for MG/LD Sample and Average-IQ/LD Group

WISC-III-Jordan Scatter Indices	MG/LD Sample (n = 30)		Average-IQ/LD Group (n = 22)		Independent sample t tests (df = 50)
	Mean Difference	SD	Mean Difference	SD	
(VIQ-PIQ) discrepancy (Regardless of direction)	12.73	11.04	7.95	8.06	1.72
(VC-PO) discrepancy	8.63	10.90	5.91	8.70	.967
Verbal Scaled Score Ranges (5 subtests) (1)	4.40	1.73	4.50	1.90	-.20
Performance Scaled Score Ranges (5 subtests) (1)	5.57	2.27	5.45	1.82	.19
Full IQ Scale (1)	7.70	1.84	6.68	1.59	2.09*

(1) *Scaled-score range is an indicator of subtest scatter within the Verbal and Performance Scale. It*

The MG/LD sample mean was also 1.73 points significantly higher than the 11.0 mean for the standardisation sample, ignoring the direction of the difference (Wechsler, 1991, Table B.2, p.266). In contrast, the mean VIQ-PIQ discrepancy of 7.95 for the Average-LD group was less than the 10.0 mean for the WISC-III standardisation sample. However, Kaufman (1994) indicated that values of about 9 to 10 points for VIQ-PIQ discrepancies (with a large SD of 7 to 8 points) have been virtual constants for Wechsler's scales from preschool to adult level. As a result, the VIQ-PIQ discrepancies among the MG/LD sample and Average-LD group were statistically significantly different from the standardised sample of the WISC-III. In fact, 60 per cent of the MG/LD sample, and 36 per cent of the Average/LD group had a significant VIQ > PIQ difference ($p < .05$) of the value of 11 points or greater, but one child from both groups had a significant discrepancy ($p < .05$) in favour of performance IQ.

The results in Table 1 also show that there is no significant difference in the Verbal Comprehension-Perceptual Organisation discrepancy [t (50) = .967, p = .338]. However, Kaufman (1994, Table 3.1, p. 102) indicated that the overall values may be significant and interpreted if the overall values for VC-PO discrepancies are 12 points at the .05 level, or 16 points at the .01 level. Further, the analysis of the Table 1 results shows that both the MG/LD sample and the Average-IQ/LD group had remarkably similar scatter with no significant differences in Verbal [t (50) = -.20, p = .844] and Performance Scaled Score Ranges [t (50) = .19, p = .849]. However, the average Full Scale Range for the MG/LD sample was 7.70, whereas it was 6.68 for the Average-IQ/LD group. As Table 5:5 shows, the scaled-score range of the two groups on the Full Scale did show a significant difference at the .05 level [t (50) = 2.09, $p < .05$]. Indeed, Kaufman (1976) found a 7-point scatter/range for the regular Full Scale to be 'virtually a built-in constant' (p. 35) as he compared this measure among levels, IQ, sex and race of the standardisation sample (cited from Moore & Wielan, 1981). Obviously, only the MG/LD sample obtained average Full Scaled Score Ranges higher than 7 points.

The Utility of Using Dynamic Assessment with the MG/LD Students
Use of the psycho-educational assessment, involving the WISC-III-Jordan was found to be an incomplete means of assessing the mathematical giftedness of the sample. Accordingly, DA involving mathematics achievement tests were used and reported.

The findings in Table 2 show the mean and standard deviation values of the dynamic mathematics tests for the MG/LD sample. There would appear to be a statistically significant difference as measured on the scale of dynamic mathematics assessment between pre-test and post-test [t (29) = 25.24, $p < .01$]. This large increase (or significant difference) in the spread of scores (7.08 points) may be a consequence of changed teaching and learning practices.

Table 2 Comparison of the Dynamic Mathematics Pre- and Post-Test Scores for the MG/LD sample

Dynamic Mathematics Tests ➊	MG/LD Sample (n = 30)				
	Min	Max	Mean	SD	Related (Paired) t test (df = 29)
Mathematics Pre-Test	8.00	14.00	10.55	1.49	
Mathematics Post-Test	15.0	20.0	17.63	1.30	
Mathematical Learning Progress (Post-Test minus Pre-Test)	4.50	10.50	7.08	1.54	25.24 **

** Significant at level P < .05* *** Significant at level P < .01*
➊ *The scores of the pre-test and post-test were out of 20 points.*

To sum up, the findings of the dynamic mathematics assessment showed that 90.4 per cent of the students who scored 120 or above on the WISC-III-Jordan (30 out of 32) showed a high variance of performance (35.4 per cent) between the pre- and post-tests. However, no significant correlations were found among mathematical learning progress in dynamic assessment, and the Arithmetic subtest of the WISC-III-Jordan.

This indicates that, contrary to the psychometric, dynamic assessment was helpful in identifying the high potential of the vast majority of the 32 students who scored above 120 Full IQ in the WISC-III-Jordan.

Auditory and Visual Perceptual Skills of the MG/LD Students

Table 3 shows the average score in each paired factor for the 30 students. Using paired sample *t* tests, nine paired factors were compared. For each paired factor, the differences were examined to determine whether or not there were any significant differences between the examined factors. Noticeably, the main points to emerge from this analysis are the relative weakness in Auditory and Visual Short-Term Memory, as noted above, and the relative weakness of overall Auditory Perceptual Skills relative to Visual Perceptual Skills.

Table 3 Paired Factors for the Visual and Auditory Perceptual Skills for the MG/LD Sample

Skills versus Skills	Paired Factors	MG/LD Sample (n = 30)		
		Mean Difference	SD	Paired Sample *t* test (df = 29)
Auditory vs. Auditory Tests and/or Skills	Auditory Discrimination - Auditory Analysis Skills	11.90	11.51	5.67 **
	Auditory Word Span - Auditory Digit Span	3.43	10.97	1.71
	Auditory Short-Term Memory – Auditory Discrimination / Analysis Skills	- 8.10	8.16	- 5.44 **
Visual vs. Visual Tests and/or Skills	Visual Motor Integration - Visual Analysis Skills	6.13	7.14	4.70 **
	Visual Short-Term Memory – Visual Integration / Analysis Skills	- 3.50	7.58	- 2.53 *
Auditory vs. Visual Tests and/or Skills	Auditory Analysis Skills – Visual Analysis Skills	- 3.57	10.28	- 1.90
	Auditory Discrimination – Visual Motor Integration	2.20	5.49	2.19 *
	Auditory Short-Term Memory – Visual Short-Term Memory	- 5.28	10.16	- 2.85 **
	Auditory Perceptual Skills -Visual Perceptual Skills	- 3.57	5.96	- 3.28 **

** Significant at level P < .05* *** Significant at level P < .01*

The findings of the Perceptual Skills Tests also revealed that the MG/LD students can be classified into four categories: (1) Auditory dyslexic students, 40 per cent of the sample, who showed good visual and poor auditory perceptual skills; (2) Visual dyslexic students, only 6.7 per cent of the sample, who showed poor visual and good auditory perceptual skills; (3) Students with Mixed Auditory and Visual difficulties, 40 per cent of the sample; and (4) Students with no perceptual problems, 13.3 per cent of the sample. On the other hand, the perceptual tests that measured the Auditory and Visual Short-Term Memory placed the sample of the MG/LD students in four categories: (1) 26.7 per cent with poor Visual but good Auditory Short-Term Memory; (2) 3.3 per cent with good Auditory but poor Visual Short-Term Memory; (3) 63.3 per cent with poor Visual and Auditory Short-Term Memory; and (4) 6.66

per cent with Visual and Auditory Short-Term Memory. This finding indicates that Auditory dyslexic students and those with Mixed Auditory and Visual difficulties formed the biggest groups in the first categorisation, while students with poor Visual and Auditory Short-Term Memory were largest group in the second categorisation.

In addition, the findings revealed that the MG/LD group, on average, have a significant difference between the Visual and Auditory Short-Term Memory (VS-TM > AS-TM). A comparison of paired factors showed that they scored above average on the Auditory Discrimination, yet low average on Auditory Analysis. They also scored a high average on the Visual-Motor Integration, but a low average on Visual Analysis. A comparison between girls and boys revealed that girls tended to have significantly higher Visual Short-Term Memory than boys.

Patterns and Levels of Learning Difficulties

The outcome of the Diagnostic Scale of Arabic Language Basic Skills revealed that although students of the MG/LD group exhibited poor spelling, writing and listening, Reading Ability was found to be the weakest literacy area. The MG/LD sample showed severe delay, between 1.23 and 2.47 grades, in all of the literacy language tests and areas. Noticeably, Reading Ability was shown as the weakest ability for all of the students regardless of their gender. This is consistent with previous studies, which indicate that reading difficulties are considered to be the most common kind of learning difficulties (Hornsby, 1997).

Conclusion and Discussion

In this section, two critical main issues emerging from the data analysis of the research will be discussed. These key issues will include: (1) using psychometric and dynamic assessment for identification; and (4) the cognitive and perceptual characteristics of these students.

Psychometric versus Dynamic Assessment for Identification

Using multiple sources of data was essential in order to strengthen the findings and conclusions. Although no single source was able, solely, to identify the 'mathematically gifted students with learning difficulties', each single source was complementary to the others, and it helped to use all of the sources together. For example, it was not possible to screen or identify students with 'dual-exceptionality' without considering teacher nominations as the first element of the identification process. Furthermore, the findings regarding the mathematics achievements in terms of the dynamic interaction between the students and their opportunity to learn added valid results to their psycho-educational assessment involving the WISC-III-Jordan and other learning difficulties tests.

Significant success in using psychometric and dynamic assessment was experienced in a previous research study that was conducted on five MG/LD students in the UK (Al-Hroub, 2002). This previous research used multi-dimensional assessment, which combined psychometric (including the WISC-III^{UK}, the Dyslexia Screening Test, and the Neale Analysis of Reading Ability) and dynamic mathematics assessments, without which any approach to assessing the students would remain inadequate. Accordingly, each case study in my pilot study and the current research consisted of a 'whole' study, in which facts were gathered from various sources and conclusions drawn from those facts. The current research suggests that this alternative method of dynamic assessment may provide a clearer diagnosis of each student's expected competence. The results demonstrated that dynamic measures are better predictors of pre-test and post-test mathematical improvement than either IQ or the initial static scores. However, it is important to note that in line with Vygotsky's theory, dynamic assessment methods should not be viewed in direct opposition to individually based static techniques such as IQ testing.

The cognitive and perceptual Characteristics

The analysis of the cognitive and perceptual characteristics of the MG/LD student in the WISC-III-Jordan and the Group of Perceptual Skills Tests (Waqfi & Kilani, 1998) bears certain similarities to and differences from these cited in previous literature. Some of these similarities and differences support findings from previous work, but in other cases the claims made in the previous literature are not supported by the findings resulting from the research into this particular sample. As a general result, the MG/LD students showed high verbal and visual abilities across the WISC-III-Jordan and perceptual skills subtests. These results suggest that the MG/LD student, on average, has harmonic mathematical abilities according to Krutetskii's (1976) classification of mathematically gifted students. Presmeg (1986) reported that the harmonic type of mathematically gifted student is most likely to possess mathematical aptitude. However, careful consideration should be given to using the characteristics of the MG/LD students as we can not generalise them to all gifted students with learning difficulties, as discussed above.

As we saw from the findings that were reported earlier, a total of 40 per cent of the MG/LD sample had 'good visual and poor auditory perceptual skills', which could be described as auditory dyslexia, while only 6.7 per cent fell into the visual dyslexic category as students with 'poor visual and good auditory perceptual skills'. This left a large percentage of about 40 per cent with mixed difficulties (both visual and auditory perceptual problems), and 13.3 per cent of the sample who were good in terms of both skills with no perceptual problems. These results conflict with those of Boder (1973) who reported that 63 per cent of her dyslexic students sample were auditory dyslexics, 9 per cent visual dyslexics, 22 per cent with mixed auditory and visual difficulties and 6 per cent undetermined. One explanation for this discrepancy may be that Boder's sample consisted only of dyslexic students. As mentioned earlier in the literature review, the neurological differences found in students with dyslexia or learning difficulties may confer advantages on some individuals (e.g. in visual or perceptual skills), which may to some extent explain the apparent paradox that some individuals who have problems with elementary skills, such as reading and writing, can nevertheless be highly gifted in other areas (Singleton, 2000). In the present research, it is important to note that the percentage of students with mixed difficulties is larger than that in Boder's study.

According the findings, the MG/LD sample tended to have significantly higher Visual Short-Term Memory (average skills) than the Auditory Short-Term Memory (below average skills). Bateson (1972) indicated that dyslexic students could be classified into three categories, based on the Illinois test of Psycholinguistic Abilities, which are: (i) good visual memory but poor auditory memory; (ii) good auditory memory but poor visual memory; (iii) poor visual and auditory memory. In this last case reading difficulty is severe and it is difficult to remedy deficits (Bateson, 1972). As we saw from the findings, the MG/LD sample showed that (i) 26.7 per cent were poor on Auditory Short-Term Memory but good on Visual Short-Term Memory; (ii) 3.3 per cent were good on Auditory Short-Term Memory but poor on Visual Short-Term Memory; (iii) 63.3 per cent were poor on both Visual and Auditory Short-Term Memory; and (iv) 6.7 per cent were good on both Visual and Auditory Short-Term Memory. This shows that for the MG/LD sample, 'poor Auditory and Visual Short-Memory' is the largest category, while 'poor Visual Short-Term Memory but good Auditory Short-Term Memory' is the smallest category. This conforms, generally, with the findings of previous studies, which indicates that (a) most of the LD students have a weak Auditory and Visual Short-Term Memory; and (b) their Auditory Short-Term Memory has tended to be weaker than their Visual Short-Term memory.

We can conclude from the finding of the current research that the MG/LD sample have weaker skills in (Auditory and Visual) Short-Term Memory than (Auditory and Visual) Perceptual Skills. This finding supports the suggestion that short-term memory is the key factor in dyslexic students or students with learning difficulties. It also could be concluded that the results conform to the substantial evidence that both phonological processing (Auditory Perceptual Skills) and short-term memory are important factors in students with learning difficulties (Singleton, 2000). It is now well-established that phonological processing ability is very closely related to reading development. In general, it is argued (a) that phonological processes underpin the development of a phonological decoding strategy in reading, and (b) that working memory plays a significant role in this strategy, enabling constituent sounds and/or phonological codes to be held in short-term store until these can be recognised as a word and its meaning accessed in long-term memory (Singleton, 2000).

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