Issues in Severe Discrepancy Measurment:
A Technical Assistance Paper For Special Educators

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Introduction

The Education of All Handicapped Children Act of 1975, Public Law Number 94-142 (PL94-142) established specific learning disabilities (LD) as a category under which children could receive special education services. The act, as amended, defines specific learning disabilities as:

(A) In general

The term 'specific learning disability' means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations.

(B) Disorders included

Such term includes such conditions as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia.

(C) Disorders not included

Such term does not include a learning problem that is primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage.

(Individuals With Disabilities Education Act Ammendments of 1997, 20 U.S.C. 1401 [26] [A-C])

Implementing rules and regulations for PL 94-142 specified that in order to make an LD diagnosis it is necessry to establish that a child has a severe discrepancy between aptitude (intellectual ability) and achievement. The rules and regulations, as amended, state that:

Sec.300.541 Criteria for determining the existence of a specific learning disability

(a) A team may determine that a child has a specific learning disability if--
(1) The child does not achieve commensurate with his or her age and ability levels in one or more of the areas listed in paragraph (a)(2) of this section, when provided with learning experiences appropriate for the child's age and ability levels; and
(2) The team finds that a child has a severe discrepancy between achievement and intellectual ability in one or more of the following areas--
(i) Oral expression;
(ii) Listening comprehension;
(iii) Written expression;
(iv) Basic reading skill;
(v) Reading comprehension;
(vi) Mathematics calculation; or
(vii) Mathematics reasoning.
(b) The team may not identify a child as having a specific learning disability if the severe discrepancy between ability and achievement is primarily the result of--
(1) A visual, hearing, or motor impairment;
(2) Mental retardation;
(3) Emotional disturbance; or
(4) Environmental, cultural or economic disadvantage.
(CFR 34, Part 300, Subpart E)

Reynold's (1984-85), in considering the testimony and commentary surrounding PL 94-142 rule and regulation development, draws two conclusions pertinent to severe discrepancy measurement. First, the idea that an LD child is one whose achievement is not commensurate with his/her aptitude was the only diagnostic criteria about which there was general agreement. Second, although a variety of procedures for calculating severe discrepancy were proposed all were mathematically inadequate and ultimately rejected. In the end, federal rules and regulations did not offer a recommended procedure for severe discrepancy calculation. The task was left to individual states.

The LD definition and diagnostic criteria stated in PL94-142 have remained with the special education field through a number of reauthorizations, including the current Individuals with Disabilities Edcation Act Amendments of 1997 (20 U.S.C. Chapter 33 § 1400-1487). State responsibility for establishing severe discrepancy calculation has also remained and been the subject of considerable discussion in the special education literature.

This technical assistance paper is intended to serve as an aid to special educators in meeting their responsibility to establish a method for measuring severe discrepancy. It describes four methods for approaching severe discrepancy calculation along with criticisms that have been leveled at each. It also describes a software program, Estimator, that incorporates a regression approach to severe discrepancy calculation generally considered to be the most defensible from a measurment point of view. The program is offered to special educators, that wish to adopt this approach, as an aid in making the necessary and somewhat pains taking calculations. Finally, it briefly describes an emerging body of research sponsored by the National Institute of Child Health and Human Development which may challenge the severe discrepancy approach to LD diagnosis, at least for young children. Should these research efforts bear fruit, federal rules and regulations may be rewritten in the future to allow for another approach to LD diagnosis . In the mean time, severe discrepancy remains a required diagnostic criteria and it is hoped this paper will prove helpful to special educators in choosing a defensible approach.

Four Approaches to Severe Discrepancy Calculation

In general, there are four approaches to severe discrepancy calculation (Cone & Wilson, 1981; Berninger & Abbott, 1994). They are (1) deviation from grade level, (2) expectancy formula, (3) standard score comparison, and (4) regression analysis. Figure 1 presents data from a study by Frakenberger & Fronzaglio (1991) that surveyed states regrading their approaches to severe discrepancy calculation. The most common approach was standard score comparison followed closely by regression analysis. Deviation from grade level and expectancy formula were adopted by only a few states. New Jersey does not appear in the figure because it has not adopted a statewide approach.

Deviation From Grade Level

Deviation from grade level formulas examine the difference between a student's grade placement and grade based achievement scores. For example, if a cutoff of two grade levels below grade place-

Deviation from grade level	Expectancy formula	Standard score comparison	Regression analysis
DC	DC	AL	AZ
HI	ID	AR	DE
	NV	CA	IA
	WI	CT	KS
		FL	KY
		GA	MD
		KS	MN
		KY	MO
		LA	MT
		ME	RI
		MS	UT
		NC	VT
		ND	WA
		NE	WV
		NM	WY
		OH	
		OK	
		RI	
		TN	
		TX	

Figure 1. Severe discrepancy approaches by states.

ment is set to define a severe discrepancey, a sixth grader achieving at a fourth grade level would be con sidered to have a severe discrepancy. Such formulas have a number of problems. First, the grade based achievement scores entered into the formula have well known problems including unequal units of measurement, the assumption that growth is constant throughout a school year, and not being comparable from one achievement test to another, among others (Sattler, 1988). Second, deviation from grade level formulas treat children at all grade levels the same. Thus, a third grade student who is achieving two years behind grade level is considered, for severe discrepancy calculation purposes, to be the same as a tenth grade student who is achieving two years behind grade level; an untenable proposition. Finally, deviation from grade level formulas identify more children with IQs below 100 as having a severe discrepancy than children with IQs above 100. To understand this, consider the data on the two students presented in Figure 2. Both students are 11 years old and in the sixth grade. Student 1 has an IQ of 80 and is achieving at the fourth grade level, an achievement level roughly commensurate with what would be expected of a student at that IQ level. Under a deviation from grade level formula that sets two years behind grade level as a cut off point, this student exhibits a severe discrepancy. Student 2 has an IQ of 120 and is achieving at the sixth grade level, an achievement level well below what would be expected for a student at that IQ level. However, under the same two years behind grade level formula used to calculate severe discrepancy for Student 1, this student does not exhibit a severe discrepancy.

Expectancy Formula

Expectancy formulas seek to define an expected grade equivalent or severe discrepancy cutoff. During proposed rule making for PL 94-142, a number of such formulas were proffered and reviewed

(Danielson & Bauer, 1978). A few examples are shown in Figure 3. The third example is a variation of a formula proposed by Harris (1970) that was nearly adopted as a national standard. In the end, however, all of the expectancy formulas were rejected primarily on the basis of their mathematical inadequacy (Reynolds, 1984-85). As Figure 3 illustrates, the proposed formulas used age and grade equivalents and treated them as if their scales had interval or ratio properties. Mathematically, this makes the results of such formulas meaningless.

Deviation from grade level severe discrepancy formula - two grade levels below grade placement		
	Student 1	**Student 2**
Age:	11 years	11 years
Grade placement:	6th	6th
IQ:	80	120
Grade level achievement:	4th grade	6th grade
Achievement level commensurate with IQ:	Yes	No
Severe discrepancy:	Yes	No

Figure 2. Illustrative example of how deviation from grade level formulas identify more students with IQs below 100 as exhibiting severe discrepancy than students with IQs above 100.

$$\text{EGE} = \#\text{ year in school } \times \frac{\text{IQ}}{100} + 1.0$$

$$\text{EGE} = \left(\text{MA} + \text{CA} + \text{Grade Age}\right) / 3 - 5$$

$$\text{SD} = \text{CA}\left(\frac{\text{IQ}}{300} + .17\right) - 2.5$$

Figure 3. Expectancy formula examples

Standard Score Comparison

Standard score comparison formulas compare IQ and achievement test standard scores to determine severe discrepancy. Generally, a cutoff is set such that if a student's achievement standard score falls a certain amount below his/her IQ standard score the student is considered to exhibit a severe discrepancy. For example, an achievement standard score 1.5 standard deviations below a student's IQ standard score might be set as a cutoff.

The standard score comparison approach assumes that IQ and achievement tests are perfectly correlated. That is, a student with an IQ of 100 will have an achievement score of 100, a student with an IQ of 85 will have an achievement score of 85, a student with an IQ of 115 will have an achievement score of 115, and so forth. This approach would be fine if the assumption of perfect correlation were true, but it is not. IQ and achivement test scores are not perfectly correlated. Because they are not, students with IQs above 100 tend to have achievement scores below their IQ scores while students with IQs below 100 tend to have achievement scores above their IQs. This is a statistical phenomenon referred to as regression toward the mean.

Because of regression toward the mean, standard score comparison formulas identify more students with IQs above 100 as having a severe discrepancy than children with IQs below 100. To understand this consider the data on the two students presented in Figure 4. Student 1 has an IQ of 130. Assume that because of the correlation between the particular IQ and achievement tests administered that Student 1's expected achievement score is 122. This is 8 points or .53 standard deviations below his IQ score of 130. Given a 1.5 standard deviation cutoff rule, Student 1 would have to have an achievement score of 107 before he was considered to have a severe discrepancy. This is 23 points or 1.5 standard deviations below his IQ score. It is also 15 points or 1 standard deviation below his expected achievement score of 122. The cutoff score for Student 1 is less than 1.5 standard deviations below his expected achievement. Student 2 has an IQ of 85. Assume again that because of the correlation between the particular IQ and achievement tests administered that Student 2's expected achievement score is 89. This is 4 points or .23 standard deviations above his IQ score of 85. Given a 1.5 standard deviation cutoff rule, Student 2 would have to have an achievement score of 62 before he was considered to have a severe discrepancy. Just as with Student 1, this is 23 points or 1.5 standard deviations below his IQ score. It is also 27 points or 1.8 standard deviations below his expected achievement score of 89. The cutoff score for Student 2 is more than 1.5 standard deviations below his expected achievement. Given a standard score comparison cutoff of 1.5 standard deviations, students with IQ scores above 100 need to meet discrepancy cutoffs less than 1.5 standard deviations below expected achievement; students with IQ scores below 100 need to meet discrepancy cutoffs greater than 1.5 standard deviations below expected achievement. This same general phenomenon holds true for any cutoff criteria established and

Standard score comparison severe discrepancy formula - achievement score 1.5 standard deviations below IQ score

	Student 1	**Student 2**
IQ:	130	85
Expected achievement score:	122	89
Points (SDs) expected achievement is below/above IQ:	8 (.53) below	4 (.27) above
Severe discrepancy cutoff score:	107	62
Points (SDs) cutoff score is below IQ:	15 (1.5)	15 (1.5)
Points (SDs) cutoff score is below expected achievement:	15 (1.0)	27 (1.8)

Figure 4. Illustrative example of how standard score comparison formulas identify more students with IQs above 100 as exhibiting severe discrepancy than students with IQs below 100.

accounts for why standard score comparison formulas identify more students with IQs above 100 as having a severe discrepancy than students with IQs below 100.

Regression Analysis

In 1983 the United States Department of Education - Special Education Programs (USDE-SEP) convened a work group on measurment issues in the assessment of learning disabilities. The work group was asked to consider from a statistical point of view what constitutes a severe discrepancy between aptitude and achievement. Chaired by Cecil R. Reynolds, this work group concluded that regression analysis was an appropriate approach to measuring severe discrepancy and recommended a particular formula for doing so (Reynolds, C. R., Berk, R. A., Gutkin, T. B., Boodoo, G. M., Mann, L., Cox, J., Page, E. B., & Willson, V. L., 1983).

Regression analysis severe discrepancy formulas do not assume that IQ and achievement tests are perfectly correlated. Rather they take into account the actual or estimated correlation between the IQ and achievement tests administered a student. Regression analysis refers to being able to predict from scores on one test scores on another test. For example, in the case of severe discrepancy analysis one wants to pre-dict from an IQ test score what a student's achievement test score should be. In order to make such a prediction, it is necessary to know the correlation between the two tests. To understand this, consider the two graphs in Figure 5. The one on the left shows a regression line for IQ and achievement tests that are perfectly correlated, that is, the correlation is 1.00. Given this perfect correlation, a student's achievement score predicted from an IQ score is the same as the IQ score. A student with an IQ score of 85 has an achievement score of 85, a student with an IQ score of 100 has an achievement score of 100, a student with an IQ score of 115 has an achievement score of 115 and so forth. The graph on the right in Figure 5 shows a regression line for IQ and achievement tests that are not perfectly correlated. The correlation is .50. When the correlation is not perfect students' achievement scores predicted from IQ are not the same as the IQ score. As the Figure 5 shows, a student with an IQ score of 85 has an achievement score of 93, a student with an IQ score of 100 has an achievement score of 100, a student with an IQ score of 115 has an achievement score of 108, and so forth. Notice that the scores are the same only at the mean. Notice also how the scores regress to the mean with achievement scores predicted for students with IQs above the mean being lower than their IQs and achievement scores for students with IQs below the mean being higher than their IQs.

The regression line for any specific pair of tests will be different depending on the correlation between the two tests. Two tests with a corrlation of .50 will have a regression line different from two test with a correlation of .60, will have a regression line different from two test with a correlation of .70, and so forth.

The regression analysis formula recommended by the USDE-SEP work group is shown in Figure 6. What the formula does is define a regression line based on the correlation between the particular IQ and achievement tests administered. In the formula, this test to test correlation is identified by the term r_{xy}. The formula also defines a cutoff line, parallel to and below the regression line, that describes the point at which one can be 95 percent confident that obtained achievement (a students actual test score) is significantly different from his/her expected achievement score (the achievement score predicted from the student's IQ). This relationship is shown graphically in Figure 7.

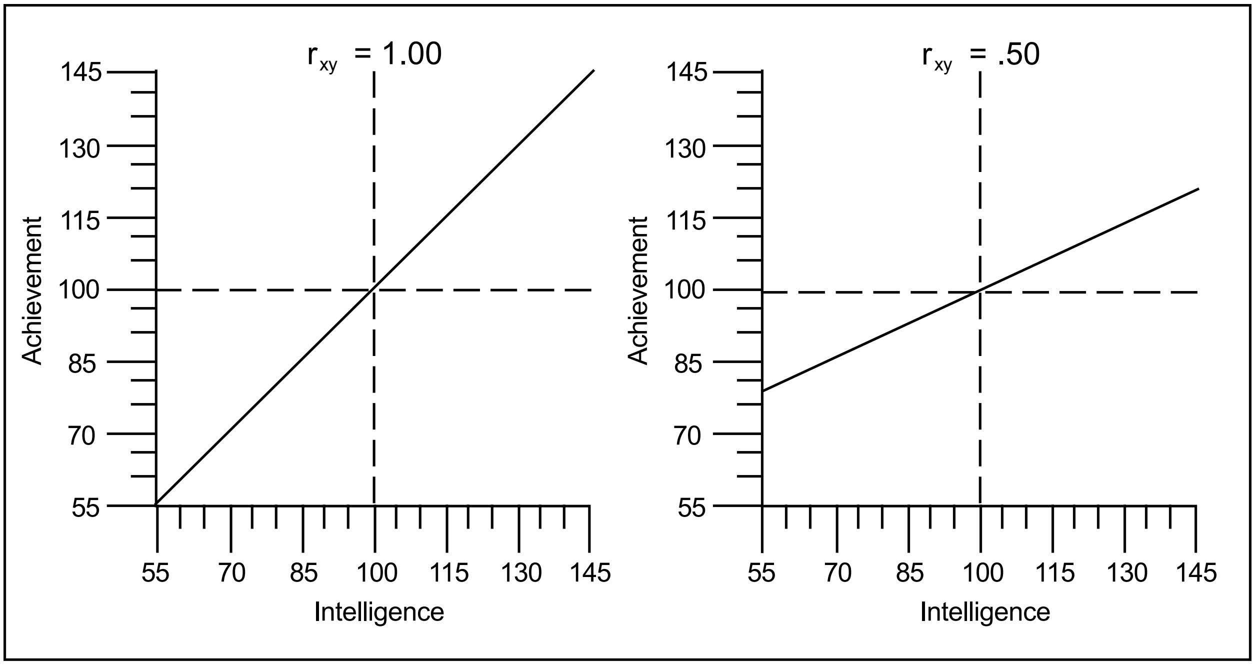

Figure 5. Illustrative example of how regression lines change as a function of differences in correlation between tests.

$$Z_{yc} = \left(z_x r_{xy}\right) - \left(\left(1.96\sqrt{1 - r_{xy}^2}\right) - \left(1.65\left(\left(\sqrt{1 - r_{xy}^2}\right)\left(\sqrt{1 - \frac{r_{yy} + \left(r_{xx} r_{xy}^2\right) - \left(2r_{xy}^2\right)}{1 - r_{xy}^2}}\right)\right)\right)\right)$$

Figure 6. Severe discrepancy formula suggested by USDE-SEP work group on measurement issues in the assessment of learning disabilities.

To further understand how the USDE-SEP work group regression analysis formula works, consider the data on the three students presented in Figure 8. All three were given IQ and achievement tests that correlate .50. Student 1 has an IQ of 85. Such a student would be expected to have an achievement score of 93. If his/her obtained achievement score is as low as 73, one can be at least 95 percent confident that obtained achievement is different from expected achievement. Student 2 has an IQ of 100. This student would be expected to have an achievement score of 100. If his/her obtained achievement score is as low as 80 one can be at least 95 percent confident that obtained achievement is different from expected achievement. Student 3 has an IQ of 85. He/she would be expected to have an achievement score of 108. If his/her obtained achievement score is as low as 88, one can be at least 95 percent confident that obtained achievement is different from expected achievement.

In addition to the test to test correlation of the IQ and achievement tests administered, the USDE-SEP work group formula considers one other test property not considered in other approaches to severe discrepancy measurement. This is the internal consistency reliability of the tests, a measure of the extent to which the items of a test are correlated and measuring the same thing. In the formula, these reliabilities are identified by the terms r_{xx} and r_{yy}. They function to move the cutoff line closer to or further away from the regression line. The higher the correlations the further the cutoff line moves from the regression line; the lower the correlations the closer it moves.

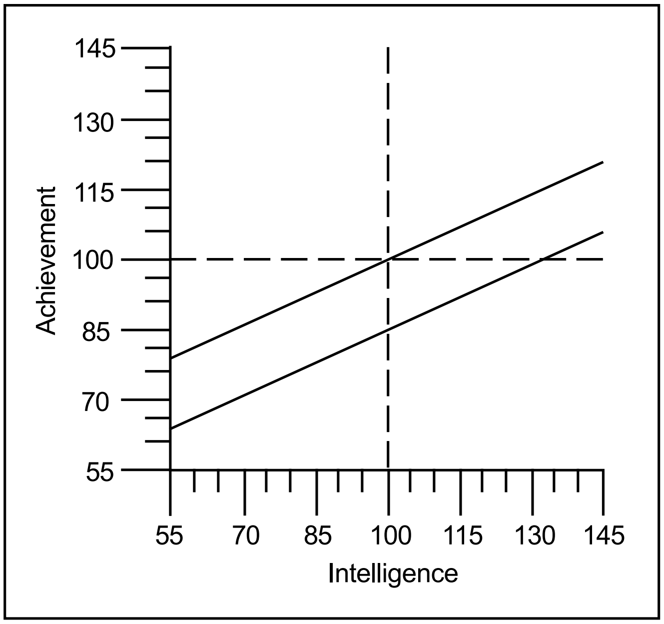

Figure 7. Graphic representation of function of USDE-SEP work group formula.

For an IQ and achievement test that is correlated .50:			
	Student 1	**Student 2**	**Student 3**
IQ:	85	100	115
Expected achievement:	93	100	108
Cutoff score at which point one can be 95% confident obtained achievement is below expected achievement:	73	80	88

Figure 8. Illustrative example of how USDE-SEP work group regression analysis formula defines cutoff scores at which one can be 95 percent confident that obtained achievement is different from expected achievement.

Estimator

In 1988 Utah adoped the USDE-SEP work group formula as its approach to severe discrepancy calculation. Using the formula requires that one know the test to test correlation and internal consistency reliability coefficients of the tests administered. Although these data are available in test manuals and the research literature finding them can be time consuming. In addition, the necessary calculations are elaborate, increasing the likelyhood of errors, and time consuming. For these reasons the Utah State Office of Education Division of Students at Risk (USOE), sought to have software developed that would contain the necessary test statistics and make the necessary calculations. The resultant software is Estimator 6.0 (Baer & Althouse, 1997). The program has users enter demographic and test information on a student then generates a report describing the student and documenting the likelyhood he/she has a severe discrepancy. It also generates a technical report showing the calculations made under the USDE-SEP work group formula.

In developing Estimator, USOE established the LD Test Selection Committee. This group of test and measurements experts, school psychologists, and speech pathologists meets monthly to review tests and make recommendations to USOE on which test should be included in the Estimator program. Through this process Estimator is continually updated. The latest version 6.0 is the third revison. Another revision is planned for release early in the 1999-2000 school year.

In 1997 a consumer evaluation of Estimator was conducted (Baer, R. D., Keene, R. D., & Althouse, B.A., 1998). Questionnaires were sent to all Utah school district special education directors with at request that they be distributed to Estimator users within the districts and returned to the program developers. Respondents reported that they used Estimator an average of 36 times per year. On a five point Likert scale from 1 equaling not at all convenient to 5 equaling extremely convenient, respondents rated how well Estimator made discrepancy calculation convenient. The mean rating was 4.12 indicating relatively high satisfaction with the program. Respondents were also asked what they liked about Estimator. The most common responses were easy to use and convenient (55%), fast and saves time (49%), liked the student report generated by the program (29%), helps to eliminate human error (11%), and helps with LD classification by providing a concrete objective basis (9%).

Recent Research by the National Institute of Child Health and Human Development

Recent research funded by the National Institute of Child Health and Human Development (NICHD) has raised questions about severe discrepancy as a diagnostic criteria for learning disabilities (Lyon, undated). Most of this research has centered on children with reading disabilities. It suggests that the ability to read is a function of a number of processes, the most important of which is phonological awareness. It further suggests that poor readers who exhibit a severe discrepancy between aptitude and achievement may not be different with respect to these processes from poor readers that do not exhibit severe discrepancies (Fletcher, J. M., Shaywitz, S. E., Shankweiler, D. P., Katz, L., Liberman, I. Y., Stuebing, K. K., Francis, D. J., Fowler, A. E., and Shaywitz, B. A., 1994). The implication for diagnosis is that reading disabilities can be diagnosed on the basis of achievement alone and that reference to IQ and/or severe discrepancy may possibly not be relevant. Should such a model be adopted, the implication for special education is that, with a reading achievement cutoff score of 90, approximately 25 percent of the school age population would qualify for special education as reading disabled (Fletcher, J. M., Francis, D. J., Shaywitz, S. E., Lyon, G. R., Foorman, B. R., Stuebing, K. K., & Shaywitz, B. A., 1998).

In conjunction with the reauthorization of IDEA 97, SEP had discussions with NICHD about its research efforts but decided not to change the learning disabilities diagnostic requirements in its implementing rules and regulations (Sheld, 1999). In the present author's opinion, the basis on which NICHD's researchers draw their conclusions needs to be studied and the implications for both general and special education carefully considered. Should their conclusions prove sound, they may have far reaching implications for how reading is taught by general education and who receives special education. Much thought and debate will need to go into the effort and it will take some time. In the mean time, the federal rules and regulations under which special education operates still require severe discrepancy as a diagnostic criteria for learning disabilities. A regression analysis approach in general, and the formula offered by the USDE-SEP work group in particular, would appear to remain the the most reasonable from a statictical point of view and the most defensible from a legal point of view.

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