DESCRIPTIVE STATISTICAL ATTRIBUTES OF SPECIAL EDUCATION DATA SETS

by

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DEDICATION

To my late husband, David, and my two children, Brittany and Courtney. Thank you for your support.
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CHAPTER 1

Introduction

Background

Micceri (1989) conducted an investigation of the distributional characteristics of 440 large-sample achievement and psychometric measures. He found all the distributions to be non-normal at nominal alpha = 0.01. Micceri indicated the factors that might contribute to a non-Gaussian error distribution in the population include (a) subpopulations within a target population, (b) ceiling effects, (c) variability in the items within a measure, and (d) treatment effects that may change the location parameter, variability, or the shape of a distribution.

Micceri (1987) also discussed the importance of statistical robustness. A statistic is robust when the assumptions of a test can be violated and still perform as expected, meaning the Type I and Type II error rates remain constant (Runyon, Coleman, et al., 2007). Micceri stated that two types of robustness are important: robustness of validity and robustness of efficiency.

Mosteller and Tukey (1977) stated that robustness of validity is that the confidence intervals for the estimate of location have a 95% chance of covering the population location regardless of the underlying distribution. Robustness of efficiency refers to high effectiveness in the face of non-normal tails. Micceri (1987) used location estimators, such as the mean and median to determine robustness of efficiency. In terms of scale, Micceri noted a distribution’s shape may influence an estimator’s robustness.

Micceri (1987) also noted that non-Gaussian distributions are prevalent in real-world data and statistical robustness should be taken into consideration when examining distributions. If robustness is not taken into consideration, then the use of statistics that are non-robust may be costly when making decisions. For example, Micceri noted that point estimators may not be robust under the conditions of heavy tailed symmetrical distributions in the presence of a single
outlier, in the presence of dependent data, in the presence of asymmetric data, and lastly, in the presence of real-world data.

Sawilowsky and Blair (1992) investigated the robustness properties of the parametric independent-samples t-test when sampling from the distributions that were identified by Micceri (1989). They confirmed that the t-test was robust to Type I error and robust when sample sizes were equal, samples sizes are fairly large and tests were two-tailed rather than one-tailed. However, when these conditions were not met, the t test was not robust. Based on the work of Micceri, Sawilowsky, and Blair, it is clear that statistics that are assumed to be normal may be non-robust in the presence of non-Gaussian distributions.

Special Education Data

Micceri (1989) examined distributions from generic social science achievement/ability tests, criterion/mastery tests, psychometric measures, and the difference between pre- and postmeasure scores. Micceri (1989) did not focus specifically on one type of social science. This study will focus specifically on examining data sets from special education instruments administered to students with disabilities.

There are numerous studies pertaining to various types of variables and statistical methods to examine students of special education achievement and progress. Achievement progress of students in special education is measured differently than students in general education. Measuring students using the Gaussian distribution may be appropriate in some instances, but not adequately measure progress in other instances. The Gaussian distribution may be used as a reference standard to measure actual behavior or real data to identify deviations (Tukey, 1977). Students are screened to determine their eligibility for special education services by using a norm-referenced test standardized to the Gaussian distribution. Although a norm-
referenced test may be appropriate for an initial screening of students, other forms of assessments that are not based on the Gaussian distribution may be more appropriate after students have entered into special education.

In addition, The No Child Left Behind Act of 2001 (NCLB, 2001) mandated that assessments are administered by the state to all students. Eckes and Swando (2009) examined the impact that the NCLB act has on students with disabilities. The study revealed that students with disabilities are expected to maintain the same proficiency levels as their general education peers. As a result, schools fail to make adequate yearly progress because of the performance of students with disabilities. For example, in the State of Michigan, students within special education are considered an aggregated, subgroup. State and local education agencies must report significant discrepancies in assessment scores between a subgroup and the general education population. Local education agencies are required to identify schools as “Focus Schools” (http://www.michigan.gov/mde/0,4615,7-140-22709_62253--,00.html) that have significant discrepancies in assessment scores between the subgroup and the general education population. Focus schools have the largest achievement gaps between its top 30% of students and its bottom 30%. Students with disabilities often are in the bottom 30%.

As Micceri (1989) mentioned, variables collected from subpopulations within a target population may not be normally distributed. The data of students in special education is considered a subpopulation or subgroup within the target group of general education students’ data. Examining distributional characteristics of special education data will allow the appropriate statistical method, a nonparametric statistical method or a parametric statistical method, to be used to measure student achievement and progress. The selection of the appropriate statistical method will contribute to the robustness of validity and efficiency as described by Micceri
(1987). Described below is a summary of distributional characteristics of data from the special education population of students who were given the 2011 MI-Access assessment that measures reading and math skills. These scores represent all students in grades 3-8 in Michigan.
Table 1

2011 MI-Access Assessment of Reading And Math Skills

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>9.375</td>
</tr>
<tr>
<td>95% Confidence Interval for Mean:</td>
<td>8.0469</td>
</tr>
<tr>
<td>Lower Bound</td>
<td></td>
</tr>
<tr>
<td>95% Confidence Interval for Mean:</td>
<td>10.7031</td>
</tr>
<tr>
<td>Upper Bound</td>
<td></td>
</tr>
<tr>
<td>5% Trimmed Mean</td>
<td>9.4722</td>
</tr>
<tr>
<td>Median</td>
<td>9.5</td>
</tr>
<tr>
<td>Variance</td>
<td>4.369</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>2.09029</td>
</tr>
<tr>
<td>Skewness</td>
<td>-1.025</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>0.739</td>
</tr>
</tbody>
</table>
The summary statistics in Table 1 indicate the distribution for these students deviates from the normal distribution. The kurtosis of 0.739 indicates that this is a flatter distribution and the negative skewness of -1.025 indicates the majority of the scores are at the upper end of the distribution. With nominal alpha set to 0.05, the Kolmogorov-Smirnov test was statistically significant (p = .022), indicating that the distribution is non-normal.

Figure 1. Q-Q Plot of the 2011 MI-Access Assessment of Reading and Math Skills

Figure 1. Q-Q Plot that describes the shape of the distribution of the MI-Access Reading and Math Assessment for students in grades 3-8. The distribution is skewed to the left with the majority of the scores concentrated on the right of the distribution.
Purpose of the Study

The aim of this study is to 1) give an overview of the types of special education assessments that are used to assess students within special education 2) examine studies that use quantitative data to measure the progress and achievement of students in special education 3) determine the distributional characteristics of special education assessment data 4) analyze special education data sets to determine if they are distributed differently and have more variability than Micceri’s (1989) distributions and 5) describe how the results from the analysis of special education data sets can be used by researchers of special education and state and local education agencies.

Limitations to the Study

This research study will have the following limitations:

1. Limited to examining data from survey studies in articles from selected special education journals.
2. Limited to examining quantitative special education assessments.

Human Subjects

Human subjects will not be used in this study. The appropriate protocols will be followed via the Institutional Review Board to apply for an exemption.

Definition of Statistical Terms

Normal distribution. A theoretical distribution used to describe various statistical concepts and empirical distributions. The normal distribution has a \( \mu = 0 \) and a \( \sigma = 1 \). The normal distribution has no skew and is mesokurtic (Runyon, Coleman, et. al., 2000). This distribution is also known as a bell curve or a Gaussian distribution (Bluman, 2007).
Parametric tests. Statistical tests for population parameters such as means, variances, and proportions that involve assumptions about the populations from which the samples were selected. One assumption is that these populations are normally distributed (Bluman, 2007).

Nonparametric statistics. Distribution-free statistics used when the population from which the samples are selected is not normally distributed. Nonparametric statistics can be used to test hypotheses that do not involve specific population parameters (Bluman, 2007).
CHAPTER 2

Literature Review

Types of Special Education Assessment Instruments and Relevance to the Education Field

Students with disabilities take a number of assessments to measure progress in various areas (Rosenberg, Westling, McLeskey, et al, 2010, p. 102-105). These assessments are often conducted with various types of instruments used to measure the progress of students with disabilities. These assessments may be summative or formative assessments. Traditional assessments or pretest, posttest assessments are standardized, norm referenced assessments. These tests may underestimate the general ability of students with disabilities (Erin& Fuchs, 2008).

Student assessments also play a key role in how teachers are evaluated. For example, in Michigan, the Michigan Council for Educator Effectiveness made the recommendation that local education agencies evaluate teachers based on 50% of their students’ growth (Michigan Council for Educator Effectiveness, 2013). However, students with disabilities are increasingly being educated in more inclusive general education settings. Many students with disabilities cannot meet the requirements to obtain a standard high school diploma (Goodman, 2011). Based on this fact, should students with disabilities’ assessment scores be included within the general education population of students in determining how teachers are evaluated? If the assessment distributions of students in special education are different, then consideration should be given to what types of assessments are administered to these students and how their progress is measured.

Brief descriptions of the various types of special education assessment instruments that are administered to students in special education are listed as follows:
Developmental Assessments. Norm-referenced scales designed to assess fine- and gross-motor, communication and language, social, cognitive, and self-help skills of infants, toddlers, and preschoolers.

Screening Assessments. Screening tests are used to help find children who might be below the norm in different areas. These tests can be pencil-and-paper tests, rating scales, or checklists used to document certain behaviors or skills and abilities.

Individual Intelligence Tests. A norm-referenced test to determine if the student’s learning problems are associated with general subaverage intellectual abilities or if other factors are contributing to a specific learning disability or emotional disturbance. Most intelligence tests report an overall or general IQ score as well as subscores in areas such as verbal skills, motor performance, and visual reasoning. Intelligence tests that are commonly used are the Wechsler Intelligence Scale for Children (3rd ed.) (WISC-III) (Wechsler, 1991), the Stanford-Binet Intelligence Scale (4th ed.) (Thorndike, Hagen, & Sattler, 1986), and the Woodcock-Johnson III Tests of Cognitive Abilities (WJ III) (Woodcock, McGrew, & Mather, 2001).

Individual Academic Achievement Tests. A multiple-skill academic achievement test that will tell how the child is progressing in academic skill such as reading, written expression, arithmetic, general information, and specific school subjects.

Adaptive Behavior Scales. Assesses daily living skills such as social behaviors, communication, motor abilities, and applying basic academic skills.

Behavior Rating Scales. Assesses the behavioral difficulties in children. Usually, the rater uses a rating scale, such as a 1-to-5-point scale, to indicate how frequent or intense the behavior is.
Curriculum-Based Measurement Assessment. Assesses a student’s skill level in a specific curriculum area at a certain point in time. This assessment may evaluate how well a student responds to intervention (Fuchs, et. al., 2003).

End of Grade, End of Course, and Alternate Assessments. Students in special education are not exempt in taking standardized assessments. Students with sensory or physical impairments are provided with accommodations on these assessments. Students with more severe intellectual special needs are evaluated using an alternate assessment.

Alternative Achievement Tests

The No Child Left Behind Act (NCLB) of 2001 requires that schools and districts demonstrate that all students are making adequate yearly progress and reach full 100% proficiency in certain academic subjects by the 2013-2014 school year. NCLB requires that schools separately report test results for subgroups of students. Students in special education are considered as a subgroup (Eckes & Swando, 2009). These students are assessed using an alternative assessment with alternate achievement standards that is different than the assessment given to students in the general education curriculum (Browder, Wakeman, et. al, 2006).

Making adequate yearly progress has been very challenging for special education subgroups. Students in special education are expected to maintain the same proficiency levels as their general education peers, which is difficult because these students start out with lower average test scores than their general education peers (Eckes & Swando, 2009).

In many states, the achievement gap between students in special education and general education students has been researched. In the state of Rhode Island, the achievement gap between special education and general education has been addressed by using different “practices that work.” Some of these practices include inclusive classrooms and activities, more
time spent on reading instruction, individualized and differentiated instruction, and using a variety of assessment forms to measure student progress (Aldridge, 2008). In the state of California, the English and math proficiency achievement levels on standardized achievement tests are initially different between general and students in special education and as each group’s proficiency level increases over time, the differences between the groups remains. The data show that for the special education subgroup to reach proficiency in math by 2013-2014, they would have to increase their math proficiency level by 9.9 percentage points as compared to another subgroup such as white students who would only need to increase their math proficiency by 5.1 percentage points. A similar achievement gap on standardized achievement tests exists between the special education subgroup and other subgroups in other states as well (Eckes & Swando, 2009).

Despite an achievement gap existing between the special education subgroup and other subgroups, students with significant cognitive disabilities are sometimes held accountable to learn the same content material as all other students (Kohl, McLaughlin & Nagle, 2006). Kohl, McLaughlin, and Nagle (2006) randomly selected 16 states and found that 14 of these states do not align curriculum content standards between the general education population and the population of students with significant cognitive disabilities. The curriculum standards for students with cognitive disabilities consist more of functional academic skills that prepare them for daily living as compared to the curriculum standards of the general education population. This mismatch in alignment between the curriculums of general education and special education in certain states’ curriculum standards may also produce an achievement gap between the populations of students in special education and general education students.
Rating Scales

Rating scales are psychometric measures used for assessing the social, emotional, and academic functioning of students (Heckaman, Conroy, East, & Chait, 2000). These scales are used in the diagnosis of behavioral, social, and/or academic disorders and in the determination of whether students need special programs (Hardman, Drew, & Egan, 2002; McConaughy & Ritter, 2002; McGinnis, Kiraly, & Smith, 1984). Lane, Carter, Pierson & Glaeser (2006) conducted a study of students’ social and behavioral skills using two types of rating scales: the Social Skills Rating System-Secondary Teachers Version (SSRS) and the Walker-McConnell Scale of Social Competence and School Adjustment. The SSRS has three subscales that measure social skills, problem behaviors, and academic competence. The social skill subscale uses a 3-point Likert-type scale (0 = never to 2 = very often) that measures how well students attends to instruction, initiates conversation with peers, and controls temper in conflict situations with peers. The problem behavior subscale is a 3-point Likert-type scale (0 = never to 2 = very often) that measures how students engage in 12 problem behaviors in two domains, internalizing and externalizing behaviors. The academic competence scale is a 5-point Likert-type scale (1 = lowest 10% of the class, 5 = highest 10% of the class) that measures the academic behavior of students in special education with their peers in the same classroom. The SCSA uses a 5-point Likert-type scale (1 = never to 5 = frequently) that has four subscales in the areas of self-control, peer relations, school adjustment, and empathy that measures how students are adjusting to the school environment.

Lane, Carter, Pierson, and Glaeser (2006) found significant differences in the population of students in special education in three academic measures on the SSRS Academic Competence scale. In addition, the special education group performed below average with mean scores almost
two standard deviations below the mean. The social domain also revealed significant differences. Students with learning disabilities had a mean score near the general education students’ mean score and students with emotional disorders had mean scores more than one standard deviation below the mean. The behavioral scale also revealed significant differences. Students with emotional disorders had higher levels of problem behaviors than students with learning disabilities. The mean score of students with learning disabilities was 100.98 as compared to students with emotional disorders with a mean of 121.57. Lane, Carter, Pierson, and Glaeser (2006) also found the social, behavioral and academic achievement gap between subgroups of students. Hence, consideration should be given to measuring the social, behavioral and academic achievement of students in special education using different statistical measures.

**Curriculum-Based Measurement Assessments**

Curriculum-Based Measurement (CBM) has been used since the 1970s and is capable of identifying at-risk students and monitoring student progress. CBM has four features: 1) psychometric characteristics for reliability and validity; 2) measures are quick to administer; 3) measures have alternate forms for frequent administration; and 4) measures are sensitive to small changes in student performance which is linked to the subject-area (Clarke, Baker, and Smolkowski, 2008). CBM has strong reliability and validity in the subject areas of reading, writing, and math skills (Fore, Boon, & Martin, et. al., 2009).

Clarke, Baker, and Smolkowski (2008) conducted a study in the subject-area of mathematics and revealed that early intervention is important for students who are at risk in mathematics. CBM in early numeracy measures was developed and investigated for use in kindergarten and first grade for over a period of four years. These early numeracy measures consisted of oral counting, number identification, quantity discrimination, and filling in missing
numbers. Students’ mathematical growth was measured using growth curve analyses. The sample data collected from the numeracy measures was examined to see if it would fit on a linear growth pattern. For the measures that did fit on a linear growth model, the slope was examined to predict a measure of students’ math performance during an academic year. Three types of predictors were used to estimate end-of-year performance. The predictors were two static measures: performance in the fall on the Stanford Early School Achievement Test (SESAT) and performance on the CBM early numeracy measure, and the last predictor was CBM measure of slope. The criterion measure was student performance on the SESAT at the end of the year. The results indicated that only the quantity discrimination numeracy measure fit on a linear growth model. The researchers of this study noted that a limitation of this study was not examining other patterns of growth that may be nonlinear. For example, examining mean scores over time may show data fitting a pattern of curvilinear growth. This study further suggests that the performance of students who are at risk should be measured differently than students who consistently show progress. In this study, structural equation modeling showed that all students may not fit on a linear growth model but other models of growth may better explain student performance. Linear growth shows a consistent pattern of student growth whereas curvilinear does not show a consistent pattern of student growth.

In a study conducted by Silberglitt and Hintze (2007), Reading Curriculum-Based Measurement (R-CBM) was used to examine the weekly reading progress and benchmark assessment progress of students in second through sixth grades. Benchmark assessments were given to the students three times a year: fall, winter, and spring. Growth rates were based on each student’s initial reading level and it was not assumed that all students would increase with the 50th percentile students’ reading level rate. The study indicated that the 50th percentile is not
typical of an underperforming student’s growth rate. It is not relevant to compare an underperforming student’s growth rate to that of their average peers. Growth rates were examined to see how they differ across groups of children within the benchmark distribution. The slopes of growth rates were examined for the bottom and top distributions of students and oral reading fluency was found to be significantly lower for groups of students who were at the bottom and uppermost distributions. The reading rate of the average student was lower than the reading rates of students below the 50th percentile. Thus, this study indicates that students who perform below average should be measured differently than their average-performing peers. The study indicated that alternative strategies should be used to measure students’ growth rates, such as comparing a student’s growth rate to that of a group of students who have similar initial levels of performance. Students who have low performance should be compared to other students who also have low performance.

**Mathematics Assessments**

The special education population of students may need testing accommodations when administered achievement tests. A testing accommodation is a change in the test presentation or format that does not alter the test (Tindal & Fuchs, 1999). Helwig and Tindal (2003) examined the results of using read-aloud accommodations on mathematics tests for students in the elementary (fourth or fifth grade) or middle school (seventh or eighth grade) who had difficulty in reading mathematical problems. Two 30-item, multiple-choice mathematics achievement tests were created in two different formats, form A and B. Form A was a standard format with several items on each page presented in written form in a test booklet. Form B had one item per page in written form in a test booklet. A video was created for each test format showing a proctor reading each item on the test. At both the elementary and middle school grade levels, the
students were assigned randomly to two groups. Group 1 took Form A in standard format and Form B in video format. Group 2 took Form A in video format and Form B in standard format. The results showed that the importance of an accommodation was rated high or very high for approximately 56% of students within special education. This study reveals that students of special education benefit from accommodations when administered tests of achievement.

Elbaum (2007) also compared the performance of middle and high school students with and without learning disabilities on a mathematics test using a standard administration and a read-aloud administration. Participants in the study ranged from grades six through ten. The mathematics instrument used met several criteria. First, the assessment needed to be similar in content, format, and response format to the multiple-choice sections on the statewide mathematics assessments. Second, two alternate forms of the assessment needed to be created with similar difficulty level. Finally, the difficulty level of the assessment had to match the skill level of the students participating in the assessment. The assessment consisted of 60 test items that were ordered by difficulty level and assigned to one of two alternate test forms. The accommodation effect sizes were calculated separately for students with and without learning disabilities who performed at or below the 50th percentile on the accommodated test. Students with learning disabilities on the top half of the score distribution had an effect size of 0.61 and students at the lower half of the distribution had an effect size of 0.02. Students without learning disabilities had effect sizes of 0.55 in the top half of the distribution and 0.11 in the lower half of the distribution. These effect sizes indicated that students with learning disabilities overall benefited more from the read-aloud accommodations on the mathematics assessment. The effect size of 0.61 indicated that the accommodation had a larger effect on students with learning disabilities as compared to the 0.55 effect size of students without learning disabilities.
Writing Assessments

Students with learning disabilities are expected to meet the same academic requirements as students without disabilities. It has been shown that students with disabilities perform well below average on standardized writing assessments (e.g., Olson, 2000; Ysseldyke et al., 1998). Essays written by students with disabilities are judged to be of poorer quality than those written by students without disabilities (Graham & Harris, 1989). Therrien, Hughes, Kapelski, and Mokhtari (2009) examined the essay-writing of seventh and eighth grade students with reading and writing disabilities. Students were assigned via random assignment to treatment and control groups in a pre/post experimental design. A comparison group of students without disabilities was also used for the posttest. The intervention used for the treatment group was The Essay Test-Taking Strategy (Hughes et. al., 2005). This strategy focused on a systematic, multistep approach to answering essay questions. Pretest and posttest essays were evaluated using two rubrics. The first rubric was specific to the strategy and was based on the steps in the Essay Test-Taking Strategy. The second rubric was a general rubric that evaluated the six analytical traits on a 5-point scale. The six traits are ideas and content, organization, voice, word choice, sentence fluency, and conventions. The posttest scores for the rubric based on the Essay Test-Taking Strategy revealed that the intervention showed a statistically significant result. The treatment group scored an average of 2.729 on the posttest compared to 0.7421 for students in the control group. Four comparisons were made for the general essay measure. Analysis of covariance results using pretest scores was used to determine whether each result in the posttest was significant. First, a comparison of mean scores was made between the treatment and control groups on the analytical trait section that was aligned with the strategy. The treatment group had an average of 4.190 and the control group scored an average of 3.263. This was a significant
result. Second, a comparison of mean scores on the other analytical traits that were not aligned with the strategy was made between the treatment and control groups and this did not reveal a significant result. Third, a comparison of mean scores on the analytical sections of the rubric that was aligned with strategy was made between the treatment and the regular education students. This result was not significant. Finally, a comparison of mean scores on the remaining analytical sections of the rubric that were not aligned with the strategy was between the treatment and regular education students and this indicated a significant difference of 8.857 and 10.7 respectively. The study indicated that students with learning disabilities may be able to perform a strategy while being instructed but they may need additional instruction to generalize the strategy to other academic requirements. Hence, students with learning disabilities need more instruction than their general education peers and how their academic progress is measured is an important factor in monitoring their progress.

Salahu-Din, et. al (2008) reported that 95% of students with disabilities were at or below the basic level of writing performance on written assessments. Students with ADHD are at risk of having writing problems (Barkley, 1997). A study conducted by Mayes, Calhoun, and Crowell (2000), revealed that 65.1% of students with ADHD have problems with written expression. Students with ADHD wrote shorter and lower quality compositions.

Jacobson and Reid (2010) used a self-regulated strategy development (SRSD). This strategy is used to teach writing skills by focusing on setting writing goals and maintaining the students’ focus on the writing task. SRSD also uses self-regulation strategies that allow the students to graphically examine their writing performance. Students with ADHD also experienced problems with working memory. The strategy teaches students to receive instruction in small increments and in prompts and cues in the initial stages of learning to lessen the
demands on the students’ working memory. Students also learned effective planning and organization to accomplish writing tasks. Jacobson and Reid (2010) studied the effects of the SRSD model on three high school students who had ADHD. The three students first participated in the baseline phase and wrote three essays. After students received a stable baseline performance, they then received instruction in the SRSD. Second, postinstruction took place which required that each student write three essays. The last phase was maintenance administered several weeks after the postinstruction phase. This phase was identical to the baseline phase.

The students were scored based on six essay parts. The six parts were to develop a topic sentence, add supporting ideas, reject at least one argument for the other side and support your opinion, end with a conclusion, number of words in the essay, and finally, quality of the essay. The quality of the essay was rated based on a 7-point Likert scale with 7 being the highest quality and 1 being the lowest quality. Results showed that baseline essays were short, lacked essay parts and were poor quality. Students spent between 27.3 minutes and 37.7 minutes planning essays. After the maintenance phase, students spent between 26 minutes and 31 minutes planning essays. The number of essay parts included in the essays increased between 133% and 257%. The number of words in the essays at the baseline phase was between 188.3 and 77.4. At the post-instruction phase, the number of words increased between 185.7 and 303.5. Baseline scores for holistic quality ranged from 2.83 to 5.17. The holistic quality of the essays increased between 165% and 300%. Finally, the transition words that students included in their essays at baseline were between 0 to 1.5. After instruction, the transition words were between 4.3 and 5 words. The results supported the notion that additional interventions are needed for students with disabilities. Although students had improvement in their writing skills, their skills were still low
and more room for improvement was needed. As a result, it should be taken into consideration that the writing performance of students with disabilities should be measured differently than the writing of students who do not have disabilities.

**Reading Assessments**

The No Child Left Behind (NCLB) Act of 2002 required that students with disabilities improve in their reading skills on a yearly basis. However, the Act did not state how much reading progress should be made by these students every year (Katz, Stone, Carlisle, et. al, 2008).

The Reading First program, which is part of the NCLB Act, implements reading programs and materials to selected schools with high levels of economic disadvantage and underachievement in reading. The program’s goal is to ensure children in grades kindergarten through third grade can read at grade level. Katz, Stone, et. al. (2008) conducted a study on Reading First Programs in the state of Michigan. They stated that it was not clear whether Reading First Schools should expect students with disabilities to make the same progress as students without disabilities. A longitudinal study from the fall of 2002 to the spring of 2004 examined the reading progress of students from the beginning of second grade to the end of third grade. A comparison was made of the reading skills between students with and without disabilities. A total of 1,512 students from 49 schools took part in the study. The DIEBELS Oral Reading Fluency and the Iowa Test of Basic Skills were the two instruments used to measure students’ progress. Propensity score methodology was used as a statistical method in comparing the two groups of students. The results on the DIEBELS oral reading fluency assessment showed that during year one of the study students with disabilities did not have the same growth rates as their nondisabled peers. Students with disabilities had an overall mean t Ratio of -0.499 as
compared to their peers who had a mean t Ratio of 3.908 based on a p-value of less than .001. During year two, students with disabilities had an overall mean t Ratio of 2.021 compared to a mean t Ratio of 8.317 for students without disabilities. On the Iowa Test of Basic Skills there was not a significant change in reading growth for neither students with disabilities or student without disabilities. This study reveals that students with disabilities had an overall slower growth rate in their reading skills as compared to students without disabilities. Measuring reading progress for students with disabilities using different methods than their peers may be necessary to adequately measure their reading progress.

According to Calhoon, Sandow, and Hunter (2010), many middle school students have reading disabilities. Approximately 70% of adolescents require remedial reading instruction (Biancarosa & Snow, 2004). Remedial instruction is not always available for students in special education so these students fall further and further behind in their reading skills.

Calhoon, Sandow, and Hunter’s (2010) research showed that teaching middle school students reading skills has primarily focused on comprehension skills and little focus has been devoted to phonics instruction. Thus, their research focused on reorganizing the reading components to include linguistics skills, spelling, reading fluency, and reading comprehension. The research program was named Reading Achievement Multi-Modular Program (RAMP-UP). Three different modules were part of the RAMP-UP Program, Alternating, Integrated, and Additive.

The Alternating module consisted of the Linguistics Skills Training program (LST) and the Peer-Assisted Learning Strategies program (PALS). These programs emphasized isolated linguistics skill instruction and reading comprehension. The Integrated module combines the instruction of spelling and fluency with linguistics skills. Finally, the Additive module develops
students’ automaticity of linguistic skills by providing isolated skills in linguistics instruction.

Students who were participants in the research had an Intelligence Quotient score of 75 or above, scored at or below a 3.5 grade level on the *Woodcock Johnson Test of Achievement-III* and *Gray Silent Reading Test*, had an Individualized Education Program (IEP), had a history of reading difficulties, and received their reading instruction from a special education teacher.

All modules were given to students during their daily special education resource room Language Arts class. The Alternating module was used as a control module to allow a comparison between the Integrated and Additive modules. Pretreatment tests showed no significant differences between the modules on all pretest reading instruments. A 3 x 2 design Analysis of Variance test was performed. Three modules and two tests – pretest and posttest were performed. Results showed a significant result and a module interaction effect for Woodcock Johnson letter word identification, word attack, and spelling tests. The oral reading fluency also had a significant result as well as a module interaction effect. However, the Woodcock Johnson Reading Fluency showed a statistically significant result and no significant module interaction effect. That research indicated that middle school students with disabilities need remedial reading instruction. The RAMP-Up program overall was very successful in increasing students’ reading skills. Hence, if students with disabilities need remedial reading, consideration should be given to measuring their reading progress differently than their peers who may perform average or above average in their reading skills. In summary, there are many assessments that can be used to assess the skills of students within special education. This study will analyze the data sets from these different assessments to determine if the distributions are more non-normal than Micceri’s (1989) social science distributions and to determine if there is more variability in special education distributions. If the distributions do differ from generic
social science distributions, then researchers of special education and state and location education agencies should give consideration on how students within special education can be assessed differently and their progress measured differently than the general education population of students.
CHAPTER 3

METHODOLOGY

Design

The aim of this study is to analyze the distribution patterns of special education assessment data. Data will be taken from published, peer-reviewed journal articles from the years of 2007-2011. In addition, research studies that have focused on special education assessment data will also be considered for use in gathering data.

Population and Sample

The target population will be data collected from the special education population and the accessible population is data from research studies representing the special education population in peer-reviewed journals and other sources. Data from special education research studies from the years 2007-2011 will be examined. A search from published journal articles from the years of 2007 to 2011 was made and a total of 396,397 related articles were found that contain special education data. Based on a margin of error of plus or minus 5% and a confidence level of 95%, a sample size of 384 data sets is needed from these articles. A return response rate of 25% is needed from these articles to accommodate for lack of responses. Based on the 25% return rate, 1,540 survey requests will be made from authors of published journal articles.

Data Gathering Methods

Research from special education research journals will be collected. A list of journals commonly used in special education research are listed as follows (Mertens & Adams, 2004):

- *American Annals of Deaf*
- American Journal on Intellectual and Developmental Disabilities
- Annals of Dyslexia
- Applied Measurement in Education
- Australasian Journal of Special Education
- Behavioral Disorders
- British Journal of Special Education
- Career Development for Exceptional Individuals
- Child Development Perspectives
- Developmental Psychology
- Early Childhood Research Quarterly
- Education and Training in Mental Retardation and Developmental Disabilities
- Education and Treatment of Children
- Educational Assessment
- Educational and Psychological Measurement
- Elementary School Journal
- Exceptional Children
- Exceptionality: A Research Journal
- International Journal of Disability
- Journal of Adolescent and Adult Literacy
- Journal of Applied Behavior Analysis
- Journal of Applied Developmental Psychology
- Journal of the Association for Persons with Severe Handicaps
- Journal of Attention Disorders
• Journal of Autism and Developmental Disorders
• Journal of Deaf Studies and Deaf Education
• Journal of Disability Policy Studies
• Journal of Early Intervention
• Journal of Educational and Behavioral Statistics
• Journal of Educational Measurement
• Journal of Educational Psychology
• Journal of Emotional and Behavioral Disorders
• Journal of Intellectual Disability Research
• Journal of the International Association of Special Education
• Journal of Learning Disabilities
• Journal of Policy and Practice in Intellectual Disabilities
• Journal of Positive Behavior Interventions
• Journal of Psychoeducational Assessment
• Journal of Research and Development in Education
• Journal of School Psychology
• Journal of Special Education
• Journal of Speech and Hearing Research
• Journal of Visual Impairment and Blindness
• Learning and Individual Differences
• Learning Disability Quarterly
• Learning Disabilities Research and Practice
• Mental Retardation
In addition, other assessment data, such as scores from assessments from state departments of education, will be used for gathering data. Requests will be made to the authors of articles via email and phone (if possible) to use their data sets for the purpose of creating statistical distributions. The authors will be requested to keep all student information confidential and only the data will be examined. Initial contact via email and phone will be made to authors of published journal articles to request survey data during the months of October through December 2012. Follow-up phone calls and email messages will be made during the month of
January 2013. At the beginning of February 2013, all data received will be analyzed and reports produced.

**Instrument Reliability and Validity**

Before collecting data from previous research journal articles, the studies will be reviewed to determine if reliability and validity studies have been conducted. Reliability of instruments used in research will be reviewed based on one or more of the following criteria:

- **Internal consistency**: The extent to which items on an instrument relate to each other. Based on Cronbach’s alpha, an internal consistency correlation of .70 or higher is considered acceptable.

- **Test-retest**: The measure of consistency of a psychological test or assessment. Based on Cohen’s guidelines, a correlation of .50 to 1.00 is acceptable between one or more assessments.

- **Interexaminer reliability**: The degree of agreement among raters about performance on an instrument. A level of .85 or higher is acceptable.

Instruments will also be reviewed for evidence containing one or more of the following validity criteria (Cicchetti, 1994):

- **Content-related validity**: How well the content of the test relates to what is being assessed.

- **Construct validity**: Tests whether concepts or measurements that are supposed to be unrelated are, in fact, unrelated.

- **Predictive validity**: The extent to which a score on a scale or test predicts scores on some criterion measure.
Data Analysis

Data requests from authors of published journals will be made via email. Data collected will be downloaded into Excel software and then exported to IBM SPSS Statistics software. Statistical distributions created from collected data will be analyzed using SPSS. The Kolmogorov-Smirnov and the Shapiro-Wilks tests will be used to examine data sets to determine if the data are normally distributed. Both tests are non-parametric tests and do not make any assumptions about the population. These tests are distribution-free and compare a data set with a standard normal distribution. If the distribution is greater than .05, then the distribution is considered to be normal. Values less than the .05 significance are non-normal. As sample sizes get larger, the Kolmogorov-Smirnov and Shapiro-Wilks tests may be sensitive to larger sample sizes thus producing significant results. Therefore, other tests of normality will be performed as described below.

Histograms will be created to give a summary of the data sets. Distributions will be described as symmetrical or asymmetrical. The mean, median, mode, standard deviation, skewness, and kurtosis will be examined from these histograms. Distributions containing a skewness equal to or close to 0 and a kurtosis equal to 3 are considered to be normal distributions. Distributions will be classified as unimodal, bimodal, and/or multimodal. Unimodal distributions have one peak or mode. Bimodal distributions have two peaks or two modes. Multimodal distributions have 3 or more modes or peaks. Normality probability plots, P-P or Q-Q plots, will be created to determine if the distributions exhibit the standard normal or Gaussian distribution. The P-P plot examines
deviations in the middle of the distribution and the Q-Q plot examines deviations in the tails of the distribution. Results of the above analyses will be presented in charts to compare and characterize the statistical distributions. Selected statistical distributions will also be presented in graphs.
CHAPTER 4
RESULTS

A total of 395 data sets were collected between the timeframe of October 2012 through June 2013 from authors of published journal articles and state departments of education. A total of 744 authors were initially contacted via email during the months of October through December. Follow-up phone calls were made during the months of January through March. Data from state departments of education consisted of 62 data sets.

Alternative academic achievement special education assessment test scores were also requested from state education departments. Twenty four states were contacted and 6 states, Michigan, South Carolina, Minnesota, Missouri, Alaska and Florida provided data. All standardized assessments used for data collection measure the progress of students in special education. Table 2 provides a summary of articles canvassed, reliability, validity, contacted authors and number of data sets received from journals. Table 3 shows the data sets collected from state departments of education. Figure 2 through Figure 396 show the histograms, skew values and names of assessments for all data sets collected. Figures 397 through 400 show the histograms, skew values and names of assessments collected from pre- and post-test data sets.
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Summary of Canvassed Journal Articles

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| Articles                                  | 9    | 33.3%               | 15   | 60.0%               | 20   | 45.0%               | 9    | 33.3%               | 11   | 36.4%               | 64    | 29.7%               |
| Acceptable Reliability                    | 3    | 33.3%               | 0    | 0.0%                | 9    | 45.0%               | 3    | 33.3%               | 4    | 36.4%               | 19    | 29.7%               |
| Acceptable Validity                       | 0    | 0.0%                | 9    | 60.0%               | 5    | 25.0%               | 1    | 11.1%               | 2    | 18.2%               | 17    | 26.6%               |
| Acceptable Articles                       | 0    | 0.0%                | 0    | 0.0%                | 4    | 20.0%               | 0    | 0.0%                | 0    | 0.0%                | 4     | 6.3%                |
| Contacted                                 | 0    | 0.0%                | 0    | 0.0%                | 2    | 10.0%               | 0    | 0.0%                | 0    | 0.0%                | 2     | 3.1%                |
| Received                                  | 0    | 0.0%                | 0    | 0.0%                | 0    | 0.0%                | 0    | 0.0%                | 0    | 0.0%                | 0     | 0.0%                |

| Journal of School Psychology              |      |                     |      |                     |      |                     |      |                     |      |                     |       |                     |
| Articles                                  | 22   | 9.1%                | 17   | 64.7%               | 9    | 45.7%               | 34   | 26.5%               | 28   | 30.9%               | 110   | 16.4%               |
| Acceptable Reliability                    | 2    | 9.1%                | 11   | 64.7%               | 6    | 66.7%               | 6    | 26.5%               | 6    | 21.4%               | 34    | 30.9%               |
| Acceptable Validity                       | 6    | 27.3%               | 9    | 52.9%               | 1    | 11.1%               | 18   | 52.9%               | 11   | 39.3%               | 45    | 40.9%               |
| Acceptable Articles                       | 0    | 0.0%                | 5    | 29.4%               | 0    | 0.0%                | 9    | 26.5%               | 4    | 14.3%               | 18    | 16.4%               |
| Contacted                                 | 0    | 0.0%                | 3    | 17.6%               | 0    | 0.0%                | 6    | 17.6%               | 4    | 14.3%               | 13    | 11.8%               |
| Received                                  | 0    | 0.0%                | 0    | 0.0%                | 0    | 0.0%                | 2    | 0.0%                | 2    | 0.0%                | 2     | 0.0%                |
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Table 3:

Data sets from State Departments of Education

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Reliability and Validity

Journal articles were reviewed for reliability and validity studies. All data collected from instruments were valid and reliable. Cronbach alpha coefficients ranged from .70 to .93. Test-retest reliability coefficients ranged from .65 to .97. Concurrent validity ranged from .70 to .89, predictive validity ranged from .65 to .86 and alternate-forms reliability ranged from .91 to .92. One study used Item response theory (IRT) measurement modeling to validate the AEPS assessment. The fit of the model ranged from .97 to 1.03.

The following figures 2 through 396 contain histograms that were created for each data set. Each histogram has the name of each data set, skew value, mean, standard deviation and n value. Q-Q and P-P plots and kurtosis values were also examined to determine the normality of each dataset. Table 7 presents whether each dataset was normal or non-normal. Figures 397 through 400 are the histograms of the pre- and post-test data sets that were collected.
Figure 2. Skew = -1.110, AEPS Level 1, Fine Motor

Figure 3. Skew = -0.545, AEPS Level 1, Gross Motor

Figure 4. Skew = 0.196, AEPS Level 1, Adaptive

Figure 5. Skew = 0.394, AEPS Level 1, Cognitive

Figure 6. Skew = 0.432, AEPS Level 1, Social Communication

Figure 7. Skew = 0.206, AEPS Level 1, Social
Figure 8. Skew = -0.117, AEPS Level 2, Fine Motor

Figure 9. Skew = -0.638, AEPS Level 2, Gross Motor

Figure 10. Skew = -0.123, AEPS Level 2, Adaptive

Figure 11. Skew = 3.715, AEPS Level 2, Cognitive

Figure 12. Skew = 2.803, AEPS Level 2, Social Communication

Figure 13. Skew = -0.545, AEPS Level 2, Social

Figure 14. Skew = 0.217, AEPS Level 2, Fine Motor

Figure 15. Skew = -0.406, AEPS Level 2, Gross Motor
Figure 16. Skew = .059, AEPS Level 2, Adaptive

Figure 17. Skew = .307, AEPS Level 2, Cognitive

Figure 18. Skew = -.246, Pre-test, Tomlinson’s differentiated instruction strategies adapted assessment

Figure 19. Skew = -1.543, Post-test, Tomlinson’s differentiated instruction strategies adapted assessment

Figure 20. Skew = .141, CBM Oral Reading Fluency, Fall

Figure 21. Skew = .076, CBM Oral Reading Fluency, Winter

Figure 22. Skew = .279, CBM Oral Reading Fluency, Spring

Figure 23. Skew = 1.884, Functional Behavior Assessment (FIT)
Figure 24. Skew = 2.090, PATM Pre-test

Figure 25. Skew = 1.340, PATM Post-test

Figure 26. Skew = -.166, BASC, Adaptive Child

Figure 27. Skew = -.592, BASC, Adaptive Matched Child

Figure 28. Skew =1.925, BASC, Adaptive Adolescent

Figure 29. Skew = 1.139, BASC, Adaptive Matched Adolescent

Figure 30. Skew = -.166, BASC, Behavioral Study Sample

Figure 31. Skew = -.592, BASC, Behavioral Matched Sample
Figure 32. Skew = .102, BASC, Clinical Child

Figure 33. Skew = .076, BASC, Clinical Matched Child

Figure 34. Skew = .391, BASC, Clinical Adolescent

Figure 35. Skew = -.022, BASC, Clinical Matched Adolescent

Figure 36. Skew = -.111, CAAVES Reading Assessment

Figure 37. Skew = -.080 CAAVES Math Assessment

Figure 38. Skew = .896 Grade 1, Fluency Word Recognition, Fall

Figure 39. Skew = .350 Grade 1, Fluency Word Recognition, Spring
Figure 40. Skew = .279  
Grade 2, Fluency Word Recognition, Fall

Figure 41. Skew = .342  
Grade 2, Fluency Word Recognition, Spring

Figure 42. Skew = -.294  
Grade 1, Reading Comprehension, Spring

Figure 43. Skew = -.758  
Grade 2, Reading Comprehension, Fall

Figure 44. Skew = -1.054  
Grade 2, Reading Comprehension, Spring

Figure 45. Skew = .134  
Grade 2, WISC-III, IQ Performance and Verbal Scales, Fall

Figure 46. Skew = 1.291  
Grade 2, Dyslexia criteria, Spring

Figure 47. Skew = -.072  
Metacognition Language
Figure 48. Skew = -0.507  
Metacognition Math

Figure 49. Skew = -0.375  
Metacognition Science

Figure 50. Skew = 0.025  
Florida Alternate Assessment, Escambia School District, Grade 3

Figure 51. Skew = -0.861  
Florida Alternate Assessment, Escambia School District, Grade 4

Figure 52. Skew = -0.382  
Florida Alternate Assessment, Escambia School District, Grade 5

Figure 53. Skew = 0.194  
Florida Alternate Assessment, Escambia School District, Grade 6

Figure 54. Skew = -0.137  
Florida Alternate Assessment, Escambia School District, Grade 7

Figure 55. Skew = -0.449  
Florida Alternate Assessment, Escambia School District, Grade 8
Figure 56. Skew = .682  
Florida Alternate Assessment, Escambia School District, Grade 9

Figure 57. Skew = .558  
Florida Alternate Assessment, Escambia School District, Grade 10

Figure 58. Skew = .457  
Florida Alternate Assessment, Desoto School District, Grade 3

Figure 59. Skew = .744  
Florida Alternate Assessment, Desoto School District, Grade 4

Figure 60. Skew = 1.242  
Florida Alternate Assessment, Desoto School District, Grade 5

Figure 61. Skew = 1.023  
Florida Alternate Assessment, Desoto School District, Grade 6

Figure 62. Skew = 1.464  
Florida Alternate Assessment, Desoto School District, Grade 7

Figure 63. Skew = .982  
Florida Alternate Assessment, Desoto School District, Grade 8
Figure 64. Skew = .992  
Florida Alternate Assessment, Desoto School District, Grade 9

Figure 65. Skew = 1.546  
Florida Alternate Assessment, Desoto School District, Grade 10

Figure 66. Skew = 1.626  
South Carolina, ELA – Level 1

Figure 67. Skew = .877  
South Carolina, ELA – Level 2

Figure 68. Skew = .639  
South Carolina, ELA – Level 3

Figure 69. Skew = -.051  
South Carolina, ELA – Level 4

Figure 70. Skew = 1.423  
South Carolina, Math Level 1

Figure 71. Skew = .148  
South Carolina, Math Level 2
Figure 72. Skew = .644  
South Carolina, Math Level 3

Figure 73. Skew = .277  
South Carolina, Math Level 4

Figure 74. Skew = -.168  
Missouri Alternate Assessment  
Communication Arts

Figure 75. Skew = -.069  
Missouri Alternate Assessment Math

Figure 76. Skew = -.245  
Missouri Alternate Assessment Science

Figure 77. Skew = -1.206  
Minnesota Access-A

Figure 78. Skew = -1.273  
Minnesota Access-C

Figure 79. Skew = -.938  
Minnesota Access-O

Figure 80. Skew = -.910  
Minnesota Access-R

Figure 81. Skew = -1.046  
Minnesota Access-W
Figure 82. Skew = .376
Minnesota Grad-M

Figure 83. Skew = -.324
Minnesota Grad-R

Figure 84. Skew = .478
Minnesota Grad-W

Figure 85. Skew = .044
Minnesota MCAII-R

Figure 86. Skew = .511
Minnesota MCAII-M

Figure 87. Skew = -.749
Minnesota MCAIII-S

Figure 88. Skew = .538
Minnesota MODII-M

Figure 89. Skew = .437
Minnesota MODII-R
Figure 90. Skew = .219
Minnesota MODIII-M

Figure 91. Skew = -1.873
Minnesota MTAS_M

Figure 92. Skew = -1.735
Minnesota MTAS_R

Figure 93. Skew = -2.420
Minnesota MTASIII-M

Figure 94. Skew = -.129
Minnesota MTASIII-S

Figure 95. Skew = .578
Minnesota MCAIII-M

Figure 96. Skew = .845
Alaska Alternate Assessment, Anchorage, Grade 3

Figure 97. Skew = .752
Alaska Alternate Assessment, Anchorage, Grade 4
Figure 98. Skew = .845  
Alaska Alternate Assessment, Anchorage, Grade 5

Figure 99. Skew = .845  
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Figure 100. Skew = .845  
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Figure 104. Skew = .845  
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Alaska Alternate Assessment, Fairbanks, Grade 5
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Alaska Alternate Assessment, Fairbanks, Grade 6

Figure 107. Skew = .845  
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Figure 108. Skew = .845  
Alaska Alternate Assessment, Fairbanks, Grade 8

Figure 109. Skew = 1.014  
Alaska Alternate Assessment, Fairbanks, Grade 9

Figure 110. Skew = .845  
Alaska Alternate Assessment, Fairbanks, Grade 10

Figure 111. Skew = .564  
Michigan MI-Access Functional Independence, Grades 3-8
Figure 112: Skew = -.219  
CBM – Second Grade

Figure 113: Skew = -.331  
CBM – Third Grade

Figure 114: Skew = -.657  
CBM – Fourth Grade

Figure 115: Skew = -.508  
CBM – Fifth Grade

Figure 116: Skew = .000  
CBM – Sixth Grade

Figure 117: Skew = .404  
CBM – Fall

Figure 118: Skew = .503  
CBM – Winter

Figure 119: Skew = .519  
CBM – Spring
Figure 120: Skew = -0.331
CBM – Fall-Winter

Figure 121: Skew = -0.219
CBM – Winter-Spring

Figure 122: Skew = -1.405 CBM – Writing
February 3-Minute Sentence Copying

Figure 123: Skew = -1.456 CBM – Writing
February 5-Minute Sentence Copying

Figure 124: Skew = 1.881 CBM – Writing
Story Prompt

Figure 125: Skew = 1.948 CBM – Writing
Picture-Word Photo

Figure 126: Skew = -1.280 CBM – Writing
May Sentence Copying – 3 minutes

Figure 127: Skew = -1.392 CBM – Writing
May Sentence Copying – 5 minutes
Figure 128: Skew = 1.914 CBM-Writing
May Story Prompt – 5 minutes

Figure 129: Skew = 1.982 CBM-Writing
May Picture word Photo – 5 minutes

Figure 130: Skew = .514 Conservation of Matter – Test 1

Figure 131: Skew = .148 Conservation of Matter – Comparison – Test 2

Figure 132: Skew = .601 Conservation of Matter – Treatment - Test 1

Figure 133: Skew = .270 Conservation of Matter – Treatment – Test2

Figure 134: Skew = -.083 CRCT – Grade 6

Figure 135: Skew = .020 CRCT – Grade 7
Figure 136: Skew = -.605 FCAT – Reading - Grade 3

Figure 137: Skew = -1.076 FCAT – Math - Grade 3

Figure 138: Skew = -1.732 FCAT – Reading - Grade 6

Figure 139: Skew = -1.089 FCAT – Math - Grade 6

Figure 140: Skew = 1.730 FCAT – Reading - Grade 10

Figure 141: Skew = -.039 FCAT – Math - Grade 10

Figure 142: Skew = 1.669 FCAT – ADHD

Figure 143: Skew = .519 FCAT – Subclinical ADHD
Figure 144: Skew = 1.315 FCAT – ADHD & Subclinical ADHD Comparison

Figure 145: Skew = .057 LSSI – Typically Achieving

Figure 146: Skew = .739 LSSI – Dyslexia

Figure 147: Skew = .423 AAMAS - Reading

Figure 148: Skew = .880 AAMAS - Math

Figure 149: Skew = -.648 NAEP - Reading

Figure 150: Skew = -1.353 NAEP - Math

Figure 151: Skew =-2.202 ACT Practice – Pre-test
Figure 152: Skew = 1.484 ACT Practice

Figure 153: Skew = .636 ACT Actual - Pre-Test

Figure 154: Skew = -.469 ACT Actual Intervention

Figure 155: Skew = -.453 Scotts Foresman – Winter- PSF

Figure 156: Skew = -.240 Scotts Foresman – Spring- PSF

Figure 157: Skew = .339 Scotts Foresman – Winter - NWF

Figure 158: Skew = .539 Scotts Foresman – Spring - NWF

Figure 159: Skew = .354 Scotts Foresman – Grade 6
Figure 160: Skew = .640 Scotts Foresman – Grade 7

Figure 161: Skew = .037 SESAT- Test 1

Figure 162: Skew = -.187 SESAT- Test 2

Figure 163: Skew = 3.389 Social Communication - Low

Figure 164: Skew = 3.371 Social Communication - PDD

Figure 165: Skew = 3.102 Social Communication - Autistic

Figure 166: Skew = -.001 TAICA - SH

Figure 167: Skew =.767 TAICA - PHA
Figure 168: Skew = -.763 TAICA - Worry

Figure 169: Skew = .042 TAICA – PE-FA

Figure 170: Skew = -.338 TAICA – Lie

Figure 171: Skew = 1.357 TAICA – CO-IA

Figure 172: Skew = .463 TAICA – TTA

Figure 173: Skew = .171 TAICA – Student with LD - Male

Figure 174: Skew = .323 TAICA – Student with LD - Female

Figure 175: Skew = -.677 TAICA – All LD Students
Figure 176: Skew = -1.294 TAICA – Students w/o LD - Male

Figure 177: Skew = .120 TAICA – Students w/o LD - Female

Figure 178: Skew = -.418 TAICA – All w/o LD

Figure 179: Skew = .001 TAKS – WJ Basic Reading

Figure 180: Skew = .031 TAKS – TOWRE

Figure 181: Skew = .064 TAKS – KBIT Verbal Knowledge

Figure 182: Skew = -.152 TAKS – KBIT Matrices

Figure 183: Skew .063 TAKS – Grade Listening Comprehension
Figure 184: Skew = -0.022 TAKS - State Administered

Figure 185: Skew = -0.120 TAKS - Experimental

Figure 186: Skew = -0.118 TAKS - Experimental Scale Score

Figure 187: Skew = -1.931 TEDI – Procedural Counting

Figure 188: Skew = -1.994 TEDI – Conceptual Counting

Figure 189: Skew = -0.076 TEDI – Seriation

Figure 190: Skew = -0.479 TEDI – Classification

Figure 191: Skew = -1.264 TEDI – Magnitude Comparison
Figure 192: Skew = -1.129 TEDI - Ad

Figure 193: Skew = -1.498 TEDI - LA

Figure 194: Skew = .254 TEDI - TA

Figure 195: Skew = -.022 TEDI - DFI

Figure 196: Skew = -.873 TEDI – DF2

Figure 197: Skew = .333 TEDI – Grade 6

Figure 198: Skew = .734 TEDI – Grade 7

Figure 199: Skew = -1.293 WMSIII-WAISIII – US-Conorm
Figure 200: Skew = -1.703 WMSIII-WAISIII – LD

Figure 201: Skew = -1.536 WMSIII-WAISIII – ADHD

Figure 202: Skew = -1.221 WMSIII-WAISIII – Verbal-Comp

Figure 203: Skew = -1.517 WMSIII-WAISIII – Perceptual Organization

Figure 204: Skew = -1.044 WMSIII-WAISIII – Processing Speed

Figure 205: Skew = .193 WMSIII-WAISIII – Working Memory

Figure 206: Skew = -1.712 WMSIII-WAISIII – Auditory Immediate Memory

Figure 207: Skew = -1.127 WMSIII-WAISIII – Visual Immediate Memory
Figure 208: Skew = -1.556 WMSIII-WAISIII – Immediate Memory

Figure 209: Skew = -.863 WMSIII-WAISIII - Auditory Delayed Memory

Figure 210: Skew = -1.43 WMSIII-WAISIII - Visual Delayed Memory

Figure 211: Skew = -.795 WMSIII-WAISIII - General Memory

Figure 212: Skew = .872 Woodcock Johnson III – Access Tech-None

Figure 213: Skew = 1.402 Woodcock Johnson III – Access Tech-One

Figure 214: Skew = .047 Woodcock Johnson III – Vision Status – low vision

Figure 215: Skew = 1.047 Woodcock Johnson III – Vision Status – total blindness
**Figure 216**: Skew = .640 Woodcock Johnson III – Visual Impaired - low vision – no wave

**Figure 217**: Skew = 1.081 Woodcock Johnson III – Visual Impaired - low vision – one wave

**Figure 218**: Skew = -.796 Woodcock Johnson III – Visual Impaired - low vision – both waves

**Figure 219**: Skew = .141 Woodcock Johnson III – Visual Impaired - blind - no wave

**Figure 220**: Skew = .955 Woodcock Johnson III – Visual Impaired - total blind – one wave

**Figure 221**: Skew = .337 Woodcock Johnson III – Visual Impaired - total blind – both wave

**Figure 222**: Skew = -.289 Woodcock Johnson III – Gender – Male

**Figure 223**: Skew = 1.187 Woodcock Johnson III – Gender - Female
Figure 224: Skew = -0.847 Woodcock Johnson III – Age 13

Figure 225: Skew = 0.810 Woodcock Johnson III – Age 14

Figure 226: Skew = -0.479 Woodcock Johnson III – Age 15

Figure 227: Skew = -0.183 Woodcock Johnson III – Age 16

Figure 228: Skew = -0.939 Woodcock Johnson III – Age 17

Figure 229: Skew = 1.218 Woodcock Johnson III – Race - White

Figure 230: Skew = 0.902 Woodcock Johnson III – Race – African American

Figure 231: Skew = -1.286 Woodcock Johnson III – Race - Hispanic
Figure 232: Skew = -.801, SEELS – Broad Independence

Figure 233: Skew = .934, SEELS – Broad Independence - Age

Figure 234: Skew = -1.018, SEELS – Broad Independence - Gender

Figure 235: Skew = .742, SEELS – Broad Independence - Income

Figure 236: Skew = .551, SEELS – Broad Independence – Race-Ethnicity

Figure 237: Skew = .649, SEELS – Broad Independence – Urbanicity

Figure 238: Skew = .835, SEELS – Broad Independence – Grade

Figure 239: Skew = .203 , SEELS – Com Living Skills Disability
Figure 240: Skew = .940  
SEELS – Com Living Skills-Age

Figure 241: Skew = 1.009  
SEELS – Com Living Skills-Gender

Figure 242: Skew = .631  
SEELS – Com Living Skills-Income

Figure 243: Skew = .584  
SEELS – Com Living Skills-Race-Ethnicity

Figure 244: Skew = .884  
SEELS – Com Living Skills-Race-Urbanicity

Figure 245: Skew = .061  
SEELS – Com Living Skills-Grade

Figure 246: Skew = .983  
SEELS – Personal Living Skills-Disability

Figure 247: Skew = -.857  
SEELS – Personal Living Skills-Age
Figure 248: Skew = -1.372
SEELS –Personal Living Skills - Gender

Figure 249: Skew = -.218
SEELS –Personal Living Skills - Income

Figure 250: Skew = -.743
SEELS –Personal Living Skills – Race/Ethnicity

Figure 251: Skew = 1.328
SEELS –Personal Living Skills – Urbanicity

Figure 252: Skew = -.087
SEELS –Personal Living Skills – Grade

Figure 253: Skew = .959
SEELS –Motor Skills Disability

Figure 254: Skew = -.629
SEELS –Motor Skills Age

Figure 255: Skew = -.118
SEELS –Motor Skills Gender
Figure 256: Skew = -.662
SEELS – Motor Skills Income

Figure 257: Skew = -.332
SEELS – Motor Skills Race-ethnicity

Figure 258: Skew = -.378
SEELS – Motor Skills Urbanicity

Figure 259: Skew = .063
SEELS – Motor Skills Grade

Figure 260: Skew = -.144
SEELS – Responsibility Disability

Figure 261: Skew = .424
SEELS – Responsibility Age

Figure 262: Skew = .056
SEELS – Responsibility Gender

Figure 263: Skew = .216
SEELS – Responsibility Income
Figure 264: Skew = .607
SEELS –Responsibility Race-Ethnicity

Figure 265: Skew = -.441
SEELS –Responsibility Urbanicity

Figure 266: Skew = .837
SEELS –Responsibility Grade

Figure 267: Skew = .175
SEELS –Self Direction Disability

Figure 268: Skew = -1.220
SEELS –Self Direction Age

Figure 269: Skew = .060
SEELS –Self Direction Gender

Figure 270: Skew = .882
SEELS –Self Direction Income

Figure 271: Skew = 1.074
SEELS –Self Direction Race
Figure 272: Skew = .111
SEELS – Self Direction Urbanicity

Figure 273: Skew = .933
SEELS – Self Direction Grade

Figure 274: Skew = .855
SEELS – Social Interaction Disability

Figure 275: Skew = -.100
SEELS – Social Interaction Age

Figure 276: Skew = .868
SEELS – Social Interaction Gender

Figure 277: Skew = .549
SEELS – Social Interaction Race

Figure 278: Skew = -.180
SEELS – Social Interaction Urbanicity

Figure 279: Skew = 1.110
SEELS – Social Interaction Grade
Figure 280: Skew = 1.472
Wave 1 Direct Assessment – Applied Problems Disability

Figure 281: Skew = 1.205
Wave 1 Direct Assessment – Applied Problems Gender

Figure 282: Skew = 1.245
Wave 1 Direct Assessment – Applied Problems Age

Figure 283: Skew = 1.651
Wave 1 Direct Assessment – Applied Problems Income

Figure 284: Skew = 1.259
Wave 1 Direct Assessment – Applied Problems Race-Ethnicity

Figure 285: Skew = 1.662
Wave 1 Direct Assessment – Applied Problems Urbanicity

Figure 286: Skew = 1.019
Wave 1 Direct Assessment – Applied Problems Grade

Figure 287: Skew = .303
Wave 1 Direct Assessment – Calculation Disability
Figure 288: Skew = -.186
Wave 1 Direct Assessment – Calculation Age

Figure 289: Skew = .348
Wave 1 Direct Assessment – Calculation Gender

Figure 290: Skew = .304
Wave 1 Direct Assessment – Calculation Income

Figure 291: Skew = .264
Wave 1 Direct Assessment – Calculation Race-Ethnicity

Figure 292: Skew = .288
Wave 1 Direct Assessment – Calculation Urbanicity

Figure 293: Skew = 1.605
Wave 1 Direct Assessment – Calculation Grade

Figure 294: Skew = 1.781
Wave 1 Direct Assessment – Letter-word Identification Disability

Figure 295: Skew = 1.189
Wave 1 Direct Assessment – Letter-word Identification Age
Figure 296: Skew = 1.612
Wave 1 Direct Assessment – Letter-word Identification Gender

Figure 297: Skew = 1.832
Wave 1 Direct Assessment – Letter-word Identification Income

Figure 298: Skew = 1.339
Wave 1 Direct Assessment – Letter-word Identification Race-ethnicity

Figure 299: Skew = 1.611
Wave 1 Direct Assessment – Letter-word Identification Urbanicity

Figure 300: Skew = 0.944
Wave 1 Direct Assessment – Letter-word Identification Grade

Figure 301: Skew = 1.703
Wave 1 Direct Assessment – Comprehension Disability

Figure 302: Skew = 0.747
Wave 1 Direct Assessment – Comprehension Age

Figure 303: Skew = 1.469
Wave 1 Direct Assessment – Comprehension Gender

Figure 304: Skew = 1.733
Wave 1 Direct Assessment – Comprehension Income

Figure 305: Skew = 1.148
Wave 1 Direct Assessment – Comprehension Race Ethnicity
**Figure 306**: Skew = 1.144  
Wave 1 Direct Assessment – Comprehension Urbanicity

**Figure 307**: Skew = .631  
Wave 1 Direct Assessment – Comprehension Grade Level

**Figure 308**: Skew = 1.197  
Wave 1 Direct Assessment – Rapid Letter Naming – Disability

**Figure 309**: Skew = .930  
Wave 1 Direct Assessment – Rapid Letter Naming – Age

**Figure 310**: Skew = 1.290  
Wave 1 Direct Assessment – Rapid Letter Naming – Gender

**Figure 311**: Skew = 1.192  
Wave 1 Direct Assessment – Rapid Letter Naming – Income

**Figure 312**: Skew = .540  
Wave 1 Direct Assessment – Rapid Letter Naming – Race Ethnicity

**Figure 313**: Skew = -.075  
Wave 1 Direct Assessment – Rapid Letter Naming – Urbanicity
Figure 314: Skew = .866
Wave 1 Direct Assessment – Rapid Letter Naming – Grade Level

Figure 315: Skew = .222
Wave 1 Direct Assessment – Segmenting Words – Disability

Figure 316: Skew = -.219
Wave 1 Direct Assessment – Segmenting Words – Age

Figure 317: Skew = -.190
Wave 1 Direct Assessment – Segmenting Words – Gender

Figure 318: Skew = .060
Wave 1 Direct Assessment – Segmenting Words – Income

Figure 319: Skew = -.594
Wave 1 Direct Assessment – Segmenting Words – Race Ethnicity

Figure 320: Skew = -.499
Wave 1 Direct Assessment – Segmenting Words – Urbanicity

Figure 321: Skew = -.499
Wave 1 Direct Assessment – Segmenting Words – Grade
Figure 322: Skew = .805  
Wave 1A Direct Assessment – Rapid Letter Naming – Grade Level

Figure 323: Skew = .210  
Wave 1A Direct Assessment – Segmenting Words – Disability

Figure 324: Skew = -.230  
Wave 1A Direct Assessment – Segmenting Words – Age

Figure 325: Skew = -.196  
Wave 1A Direct Assessment – Segmenting Words – Gender

Figure 326: Skew = .070  
Wave 1A Direct Assessment – Segmenting Words – Income

Figure 327: Skew = -.603  
Wave 1A Direct Assessment – Segmenting Words – Race Ethnicity

Figure 328: Skew = -.501  
Wave 1A Direct Assessment – Segmenting Words – Urbanicity

Figure 329: Skew = .050  
Wave 1A Direct Assessment – Segmenting Words – Grade
**Figure 330:** Skew = .852  
Wave 2 Direct Assessment – Applied Problems- Disability

**Figure 331:** Skew = 1.656  
Wave 2 Direct Assessment – Applied Problems - Age

**Figure 332:** Skew = 1.252  
Wave 2 Direct Assessment – Applied Problems – Gender

**Figure 333:** Skew = 1.721  
Wave 2 Direct Assessment – Applied Problems Income

**Figure 334:** Skew = .837  
Wave 2 Direct Assessment – Applied Problems – Race Ethnicity

**Figure 335:** Skew = .016  
Wave 2 Direct Assessment – Applied Problems - Urbanicity

**Figure 336:** Skew = 1.172  
Wave 2 Direct Assessment – Applied Problems – Grade

**Figure 337:** Skew = .989  
Wave 2 Direct Assessment – Calculation- Disability
Figure 338: Skew = -.818
Wave 2 Direct Assessment – Calculation-Age

Figure 339: Skew = .900
Wave 2 Direct Assessment – Calculation-Gender

Figure 340: Skew = 1.133
Wave 2 Direct Assessment – Calculation-Income

Figure 341: Skew = 1.312
Wave 2 Direct Assessment – Calculation-Race Ethnicity

Figure 342: Skew = -.938
Wave 2 Direct Assessment – Calculation-Urbanicity

Figure 343: Skew = 1.721
Wave 2 Direct Assessment – Calculation-Grade

Figure 344: Skew = 1.754
Wave 2 Direct Assessment – Letter word Identification - Disability

Figure 345: Skew = 1.685
Wave 2 Direct Assessment – Letter word Identification Age
Figure 346: Skew = 1.612
Wave 2 Direct Assessment – Letter word Identification – Gender

Figure 347: Skew = 1.786
Wave 2 Direct Assessment – Letter word Identification – Income

Figure 348: Skew = 1.353
Wave 2 Direct Assessment – Letter word Identification – Race Ethnicity

Figure 349: Skew = 1.215
Wave 2 Direct Assessment – Letter word Identification – Urbanicity

Figure 350: Skew = .806
Wave 2 Direct Assessment – Letter word Identification – Grade

Figure 351: Skew = 1.340
Wave 2 Direct Assessment – Comprehension – Disability

Figure 352: Skew = .097
Wave 2 Direct Assessment – Comprehension – Age

Figure 353: Skew = 1.336
Wave 2 Direct Assessment – Comprehension – Gender
Figure 354: Skew = 1.838
Wave 2 Direct Assessment – Comprehension – Income

Figure 355: Skew = .659
Wave 2 Direct Assessment – Comprehension Race Ethnicity

Figure 356: Skew = .415
Wave 2 Direct Assessment – Comprehension – Urbanicity

Figure 357: Skew = 1.340
Wave 2 Direct Assessment – Comprehension - Grade

Figure 358: Skew = .846
Wave 2 Direct Assessment – Rapid Letter Naming – Disability

Figure 359: Skew = 1.655
Wave 2 Direct Assessment – Rapid Letter Naming - Age

Figure 360: Skew = 1.768
Wave 2 Direct Assessment – Rapid Letter Naming – Gender

Figure 361: Skew = -.640
Wave 2 Direct Assessment – Rapid Letter Naming - Income
Figure 362: Skew = 1.719
Wave 2 Direct Assessment – Rapid Letter Naming – Race Ethnicity

Figure 363: Skew = -.265
Wave 2 Direct Assessment – Rapid Letter Naming - Urbanicity

Figure 364: Skew = 1.826
Wave 2 Direct Assessment – Rapid Letter Naming – Grade

Figure 365: Skew = -.036
Wave 2 Direct Assessment – Segmenting Words - Disability

Figure 366: Skew = -.036
Wave 2 Direct Assessment – Segmenting Words – Age

Figure 367: Skew = -.110
Wave 2 Direct Assessment – Segmenting Words - Gender

Figure 368: Skew = 1.831
Wave 2 Direct Assessment – Segmenting Words – Income

Figure 369: Skew = .048
Wave 2 Direct Assessment – Segmenting Words – Race Ethnicity
Figure 370: Skew = .649  
Wave 2 Direct Assessment – Segmenting Words – Urbanicity

Figure 371: Skew = -.283  
Wave 2 Direct Assessment – Segmenting Words - Grade

Figure 372: Skew = 1.000  
Wave 3 Direct Assessment – Applied Problems – Disability

Figure 373: Skew = .984  
Wave 3 Direct Assessment – Applied Problems - Age

Figure 374: Skew = 1.173  
Wave 3 Direct Assessment – Applied Problems- Gender

Figure 375: Skew = 1.218  
Wave 3 Direct Assessment – Applied Problems - Income

Figure 376: Skew = 1.394  
Wave 3 Direct Assessment – Applied Problems Race Ethnicity

Figure 377: Skew = .664  
Wave 3 Direct Assessment – Applied Problems - Urbanicity
Figure 378: Skew = 1.763
Wave 3 Direct Assessment – Applied Problems - Grade

Figure 379: Skew = 1.671
Wave 3 Direct Assessment – Calculation - Disability

Figure 380: Skew = 1.542
Wave 3 Direct Assessment – Calculation - Age

Figure 381: Skew = 1.386
Wave 3 Direct Assessment – Calculation – Gender

Figure 382: Skew = 1.324
Wave 3 Direct Assessment – Calculation – Income

Figure 383: Skew = 1.440
Wave 3 Direct Assessment – Calculation – Race Ethnicity

Figure 384: Skew = 1.459
Wave 3 Direct Assessment – Calculation – Urbanicity

Figure 385: Skew = 2.225
Wave 3 Direct Assessment – Calculation - Grade
Figure 386: Skew = 1.436
Wave 3 Direct Assessment – Letter word Identification – Disability

Figure 387: Skew = 1.098
Wave 3 Direct Assessment – Letter word Identification – Age

Figure 388: Skew = 1.147
Wave 3 Direct Assessment – Letter word Identification – Gender

Figure 389: Skew = 1.272
Wave 3 Direct Assessment – Letter word Identification – Income

Figure 390: Skew = 1.320
Wave 3 Direct Assessment – Letter word Identification – Race Ethnicity

Figure 391: Skew = 1.165
Wave 3 Direct Assessment – Letter word Identification – Urbanicity

Figure 392: Skew = 1.205
Wave 3 Direct Assessment – Letter word Identification – Grade

Figure 393: Skew = 1.225
Wave 3 Direct Assessment – Comprehension – Disability
Figure 394: Skew = .950
Wave 3 Direct Assessment – Comprehension – Age

Figure 395: Skew = 1.099
Wave 3 Direct Assessment – Comprehension – Gender

Figure 396: Skew = 1.267
Wave 3 Direct Assessment – Comprehension– Income

Figure 397. Skew = -.246, Pre-test, Tomlinson’s differentiated instruction strategies adapted assessment

Figure 398. Skew = -1.543, Post-test, Tomlinson’s differentiated instruction strategies adapted assessment

Figure 399. Skew = 2.090, PATM Pre-test

Figure 400. Skew = 1.340, PATM Post-test
Classification of Data sets

Each histogram was analyzed and categorized. Histograms that resembled Micceri’s (1987) distributions were named accordingly. Histograms that did not resemble Micceri’s distributions were given a name based on the shape of each distribution. Table 4 shows the figures that resemble Micceri’s distributions and Table 5 shows the new classification of special education distributions.

Confidence Interval

Based on an estimated accessible population of 1,540, the obtained sample size of 395 yielded a confidence level of 95% with a ±4.25% margin of error.

Table 4 below shows the special education assessment histograms that resembled Micceri’s distributions. The histograms were classified based on the shape of each distribution. The corresponding name of each distribution and histogram figure is listed.

Table 4:

Classification of Data sets based on Micceri’s Distributions

<table>
<thead>
<tr>
<th>Distributions</th>
<th>Histogram Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Asymmetry</td>
<td>4 8 17 24 25 223</td>
</tr>
<tr>
<td>Mass at Zero</td>
<td>21</td>
</tr>
<tr>
<td>Extreme Bimodality</td>
<td>50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65</td>
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<tr>
<td></td>
<td>85 87 88 89 95 124 125 126 127 128 129 151 155 156 163 164</td>
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<tr>
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<td>165 174 175 176 179 181 183 187 188 189 190 193 200 206 208 232</td>
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<tr>
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<td>238 239 240 244 248 274 275 277 280 281 282 283 284 285 290 292</td>
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<td>344 345 347 351 353 354 357 358 359 360 362 364 368 373 376 378</td>
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<td>379 381 384 386 389 390 393 394 395 396</td>
</tr>
<tr>
<td>Digit Preference</td>
<td>13 22 37 45</td>
</tr>
<tr>
<td>Multimodality and Lumpiness</td>
<td>2 3 5 6 7 18 36 39 40 41 47 68 69 73 76 131</td>
</tr>
<tr>
<td></td>
<td>149 160 377</td>
</tr>
<tr>
<td>Smooth Symmetric</td>
<td>20</td>
</tr>
</tbody>
</table>
Table 5 below shows the special education assessment histograms that do not resemble Mucciari’s distributions. The histograms were classified based on the shape of each distribution. A new distribution name was created for distributions that resembled each other. The corresponding name of each distribution and histogram figure is listed.

**Table 5:**

*Classification of Data sets based on New Special Education Distributions*

<table>
<thead>
<tr>
<th>Distributions</th>
<th>Histogram Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unimodality and Slightly Lumpy</td>
<td>9 10 66 70</td>
</tr>
<tr>
<td>Unimodal and Smooth</td>
<td>138 140 142 152 154 157 158 159 166 167 168 170 171 173 178 186</td>
</tr>
<tr>
<td></td>
<td>191 192 197 212 213 214 215 216 217 220 222 224 225 226 227 230</td>
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<tr>
<td></td>
<td>233 234 235 237 241 242 246 254 255 256 257 258 262 265 266 267</td>
</tr>
<tr>
<td></td>
<td>269 272 273 276 278 279 320 328 331 341 343 372 382 385 387</td>
</tr>
<tr>
<td>Unimodality and Slightly Smooth</td>
<td>14 16 71 130 132 133 134 145 146 198</td>
</tr>
<tr>
<td>Slight Asymmetry</td>
<td>15 23 26 32 38 42 43 44 79 80 81 97 101 103 108 147</td>
</tr>
<tr>
<td></td>
<td>150 172 177 196 229 231 247 388 392</td>
</tr>
<tr>
<td>Slightly Asymmetric and Digit Preference</td>
<td>19 48 49 67 374 375</td>
</tr>
<tr>
<td>Equimodal</td>
<td>31 77 78 84 86 90 91 96 102 106 109 110 112 113 114 115</td>
</tr>
<tr>
<td></td>
<td>116 117 118 119 120 121 136 137 139 141 143 144 153 161 162 169</td>
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<td>180 199 201 202 203 204 205 207 209 210 211 243 260 286 287 288</td>
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<td>289 291 296 298 300 302 305 306 307 309 310 311 312 313 314 315</td>
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<td>316 317 321 322 323 324 325 329 330 334 335 336 337 338 339 340</td>
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<tr>
<td></td>
<td>346 348 349 350 352 355 356 361 363 365 366 367 369 370 371 391</td>
</tr>
<tr>
<td>Equimodal and Slight Asymmetry</td>
<td>74</td>
</tr>
<tr>
<td>Equimodal and Symmetric</td>
<td>75 135 219</td>
</tr>
<tr>
<td>Slightly Smooth and Symmetric</td>
<td>72</td>
</tr>
<tr>
<td>Extreme Mass at Zero</td>
<td>11 12</td>
</tr>
<tr>
<td>Bimodal and Smooth</td>
<td>27 28 33 34 99 100 148 182 184 185 194 195 218 221 228 236</td>
</tr>
<tr>
<td></td>
<td>245 249 250 251 252 253 259 261 263 264 268 270 271 380 383</td>
</tr>
</tbody>
</table>
Table 6 lists the types of distributions, how many of each distribution was found and the percentage of each type of distribution found.

**Table 6:**

*Percentage and Number of Each Distribution Shape*

<table>
<thead>
<tr>
<th>Type of Distribution</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Asymmetry</td>
<td>6</td>
<td>1.52%</td>
</tr>
<tr>
<td>Mass at Zero</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Extreme Bimodality</td>
<td>106</td>
<td>26.84%</td>
</tr>
<tr>
<td>Digit Preference</td>
<td>4</td>
<td>1.01%</td>
</tr>
<tr>
<td>Multimodality and Lumpiness</td>
<td>19</td>
<td>4.8%</td>
</tr>
<tr>
<td>Smooth Symmetric</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Unimodality and Slightly Lumpy</td>
<td>4</td>
<td>1.01%</td>
</tr>
<tr>
<td>Unimodal and Smooth</td>
<td>79</td>
<td>20%</td>
</tr>
<tr>
<td>Unimodality and Slightly Smooth</td>
<td>10</td>
<td>2.53%</td>
</tr>
<tr>
<td>Slight Asymmetry</td>
<td>25</td>
<td>6.33%</td>
</tr>
<tr>
<td>Slightly Asymmetric and Digit Preference</td>
<td>6</td>
<td>1.52%</td>
</tr>
<tr>
<td>Equimodal</td>
<td>96</td>
<td>24.30%</td>
</tr>
<tr>
<td>Equimodal and Slight Asymmetry</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Equimodal and Symmetric</td>
<td>3</td>
<td>0.76%</td>
</tr>
<tr>
<td>Slightly Smooth and Symmetric</td>
<td>1</td>
<td>0.25%</td>
</tr>
<tr>
<td>Extreme Mass at Zero</td>
<td>2</td>
<td>0.51%</td>
</tr>
<tr>
<td>Bimodal and Smooth</td>
<td>31</td>
<td>7.85%</td>
</tr>
</tbody>
</table>
Table 7 lists each data set by histogram figure and lists whether each data set is normal or non-normal.

**Table 7:**

*Tests of Normality*

<table>
<thead>
<tr>
<th>Histogram Figure</th>
<th>Kolmogorov-Smirnov</th>
<th>Shapiro-Wilks</th>
<th>Kolmogorov-Smirnov</th>
<th>Shapiro-Wilks</th>
</tr>
</thead>
<tbody>
<tr>
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<td>non-normal</td>
<td>26</td>
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<td>3</td>
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</tbody>
</table>
Table 7:

Tests of Normality

<table>
<thead>
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Tests of Normality

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CHAPTER 5

DISCUSSION

Based on Table 6 above, there were 65.31% or 258 special education distributions that were different than Micceri’s distributions. There were 34.67% or 137 distributions classified based on Micceri’s distribution shapes.

Data sets were also analyzed for normality and compared to the normality of Micceri’s data sets. Based on the Kolmogorov-Smirnov and Shapiro-Wilks tests, there were 318 data sets, or 81%, that were non-normal and 77 data sets, or 19% that were normal. The Kolmogorov-Smirnov test had 199 data sets that were non-normal, or 50%, and 196 data sets that were normal, or 50%. The Shapiro-Wilks test had 119 data sets that were non-normal, or 30%, and 276 data sets that were normal, or 70%.

Recall that Micceri (1987, 1989) used the Kolmogorov-Smirnov test of normality and found 100% of the distributions to be significantly non-normal at the .01 alpha level. There were 19 out of 440 distributions, or 4.3%, that were considered reasonable approximations to the Gaussian distribution. As compared with Micceri’s (1987, 1989) results, this study shows special education assessment data sets were more likely to be normal, although about four out of five data sets were non-normal. The number of different types of data sets was higher, indicating there is more variability in the distributions of special education data sets than those found by Micceri (1987, 1989).
Based on the different types of variability of special education data sets found in this study, this may impact how teachers convey academic content to students within special education. In addition, state and local education agency special education directors and directors of assessment and evaluation may want to reconsider the policies and procedures that determine how students are evaluated. Following is how the results of this study may impact the academic content conveyed to students as well as the policies and procedures that determine how students are evaluated within special education.

**Variability of Data sets that may Impact Academics**

The results of this study revealed higher numbers of distribution classifications in the extreme bimodality, unimodal and smooth and equimodal classifications of distribution shapes. There were 106 extreme bimodality distributions and 57%, or 60 data sets, were non-normal. There were 46 distributions that were normal. There were 79 unimodal and smooth distributions and 29%, or 23 data sets, were non-normal. The remaining category which had a large amount of distributions is the equimodal category. There were 96 distributions and 70%, or 67, were non-normal. Thirty percent of the equimodal distributions were normal. All data sets were tested for normality using the Kolmogorov-Smirnov and/or Shapiro-Wilks normality tests. The variability of classifications of data sets reveals that students in special education have variable results. A further analysis revealed that curriculum-based measurement assessments in writing, alternative assessments, applied problem solving, calculation, mathematics operations, reading, letter-word identification, segmenting words and letter naming exhibited non-normal data. Assessments that demonstrated students’ fine motor and/or gross motor skills had high normality. The Woodcock Johnson tests revealed data sets with higher results of normality. These tests are norm-referenced
and standardized to the Gaussian distribution which is a possible reason why these data sets were normal.

Based on the variability and classification of data sets, students in special education may need more assistance in developing skills in the core-curriculum content areas. Students may also improve their skills using hands-on manipulatives to learn academic content as the results of the fine motor and gross motor skills assessments revealed high normality.

Micceri’s (1987, 1989) results revealed that all data sets were non-normal. Examining special education data sets revealed both normal and non-normal data because of the varied types of assessments administered to students in special education. For example, assessments that measure academic skills may yield different results than assessments that measure fine or gross motor skills.

**Impact of Findings and Implications for Further Research**

Based on the results of this study, it is important to consider statistical robustness when examining special education assessment distributions. When analyzing the data of students in special education, a nonparametric statistical method as compared to a parametric statistical method may be the best method to measure student achievement and progress. As the results indicated, 81% of the special education distributions in this study were non-normal based on the Kolmogorov-Smirnov and/or the Shapiro-Wilks normality tests. The total non-normality for the Kolmogorov-Smirnov test was 50% and the total non-normality for the Shapiro-Wilks test was 30%.

Based on the results of this study, a researcher of special education assessment data is more likely to encounter data sets like Micceri’s that have extreme bimodality and special education data sets that are unimodal and smooth or equimodal. Monte Carlo studies may be
conducted to show the robustness and power properties of statistical tests that should be taken into consideration when using these new shapes.

The new special education data shapes in this study may overlap with Micceri’s data shapes. Due to the small sample size of the special education data sets, some of the shapes were different than Micceri’s data shapes. However, if there were larger sample sizes for each special education data set, then it is possible to receive the same data shapes as Micceri’s shapes.

For example, the data sets for the Florida Alternate Assessment were separated by grade level and a distribution was created for each data set because the achievement of students in special education is measured based on a set of academic standards for each grade level. However, if the sample size is broadened for Figure 51: Florida Alternate Assessment, Escambia School District, Grade 4, then Micceri’s discrete mass at zero shape will be created from the data set. If all the data sets for all grade levels of the Florida Alternate Assessment, Escambia School District, are concatenated, then the distribution will look like Figure 401.

![Figure 401. Concatenated Special Education Data Set](image)


Limitations of Study and Next Steps

Micceri’s (1989) study was based on 440 large data sets from the social and behavioral sciences. The data sets obtained for this study, however, originated from a smaller subpopulation obtained from special education. The variety of data sets was greater and the percentage of non-normally shaped datasets was smaller than that found by Micceri (1989). However, the sample sizes in the current study were typically much smaller than those obtained by Micceri (1989), which may account for these two differences. Although Micceri’s (1989) data sets were subsequently used in simulation studies as being representative based on their generally large sample sizes (eg., Sawilowsky, Blair, & Micceri, 1990), small sample data sets obtained in this study should not be used for that purpose. Data sets obtained from the Special Education Elementary Longitudinal, Wave 1 Direct Assessment, Wave 2 Direct Assessment and Wave 3 Direct Assessment study which contains over 5,000 data sets may be used for simulation studies. Special education data set shapes in the extreme bimodality, equimodal and unimodal and smooth categories had very large data sets. Table 8 shows a comparison of data set sample size between Micceri’s (1989) study and this study.

Table 8

Comparison of Data Set Sample Sizes

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<th>Micceri’s Sample Size Data Sets</th>
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<td>N = 190 - 10,893</td>
<td>N = 10 - 5,000</td>
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Assessment data of specific disability categories within special education were not examined. Examining subpopulations of data within the special education assessment data population to determine how data is distributed and whether different types of special education
assessments have different statistical properties may be beneficial. For example, to determine if students with disabilities have more extreme deficits in academic, social skills, psychological, behavioral or other domains, state and local education agencies may want to compare the performance of a target group with one or more groups with other disabilities (Mervis, 2004). A group-matching design using non-parametric statistics is one of the ways in which to compare subpopulations of data within the special education data population (Kover & Atwood, 2013). Parametric statistics need not be re-examined for the new special education data shapes that were non-normal in this study. A collection of real pre-test and post-test data sets in special education will inform a researcher of special education of what types of non-parametric statistical tests are best for measuring the progress of students in special education. In addition, state and local education agencies may reconsider how assessment scores of students with disabilities may affect the outcome of teacher evaluations. As this study has shown, 81% of the special education distributions were non-normal based on the Kolmogorov-Smirnov and/or the Shapiro-Wilks normality tests and there is more variability in special education distributions.
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maximize middle school students with reading disabilities’ response to treatment? *Ann. of Dyslexia, 60*, 57-85.

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*Teachers College Record*, doi:10.1111

*Teaching Exceptional Children*, doi:10.1177


Micceri (1989) examined the distributional characteristics of 440 large-sample achievement and psychometric measures. All the distributions were found to be non-normal at alpha = .01. Micceri indicated three factors that might contribute to a non-Gaussian error distribution in the population. The first factor is subpopulations within a target population. The second factor is ceiling effects and the third factor is treatment effects that may change the location parameter, variability, or shape of the distribution.

This present study examined the distributional characteristics of special education assessments and determined whether these distributions were differently distributed than Micceri’s distributions. Three hundred ninety five data sets were collected, examined and classified according to distribution shape. The classification findings were compared with Micceri’s (1989) classification distributions. The findings indicated that there were more classifications of special education data sets and these distributions were differently distributed than Micceri’s distributions. There were 258, or 65.31%, of special education distributions that were different than Micceri’s (1989) distributions. One hundred thirty seven, or 34.67%, of special education distributions were similar to Micceri’s distributions.
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AUTOBIOGRAPHICAL STATEMENT
ak3998@wayne.edu

EDUCATION
- **Doctor of Philosophy** - Evaluation and Research, Wayne State University, 2009-2013
- **Master of Science** - Computer and Information Systems – Software Management, University of Detroit Mercy, 1993-1995
- **Bachelor of Business Administration**, Davenport University, 1986-1990
- **Professional Teaching Certification** - Elementary Education, Science, Learning Disabilities, Cognitive Impairments, Wayne State University, 2002-2006

EMPLOYMENT HISTORY
- **Education Research Consultant** for the State of Michigan, Michigan Department of Education, (2012-Present)
- **Educator** - science and special education Detroit, Southfield, and Highland Park Public Schools (2002-2012)
- **Information Technology Consultant** - quality assurance, testing and programming (1995-2000)

PROFESSIONAL EXPERIENCE
*Research and Evaluation, Information Technology, and Administration*
- Coordinate a team in the research and evaluation of grants and budgets. Review grant activities and budgets that range from $500,000 to 1 million dollars.
- Conduct quantitative risk analysis on grant applications to assess the probability of achieving project outcomes.
- Microsoft SQL Server used to extract and analyze over 3,000 records of assessment and student data to create technical assessment summary and enrollment data reports.
- Statistical t-tests used to compare students’ quarterly reading performance on reading assessments. Analyzed results of t-tests to modify teaching instruction.
- Analyzed student data of 100 students from various state tests (MEAP, Terra Nova, etc.) and brainstormed ideas to help students improve in subject areas that had low percentages.
- Developed testing procedures – test cases and test scripts for applications in healthcare, manufacturing, energy management and banking industries.
- Michigan Electronic Grants Systems (MEGS+) Department Liaison: Represent Office of Career and Technical Education at team meetings to discuss MEGS+ requirements, testing and technical issues. Troubleshoot and coordinate post implementation support and report problems to MEGS+ Development and Testing Team. Trained new co-worker to use MEGS+.
- Conduct professional development workshops, webinars and provide technical assistance on technical assessment processes and procedures for 55 career and technical education programs.
- Collaborate with internal program consultants, cluster referent groups of business and industry and teachers to understand and adopt technical education processes and testing requirements for career and technical education programs.
- Develop partnerships and collaborate with assessment vendors to adopt, monitor and implement career and technical assessments. Established registration, ordering and implementation processes and procedures for technical assessments.
- Developed assessment monitoring plan for career and technical education programs.
- Projected budget and assessment costs for data analytical testing projects that ranged from $500,000 to 1 million dollars.