A COMPARISON OF THREE INSTRUCTIONAL METHODS FOR TEACHING
MATH SKILLS TO SECONDARY STUDENTS WITH
EMOTIONAL/BEHAVIORAL DISORDERS

DISSERTATION
Presented to the Graduate Council of
Texas State University-San Marcos
in Partial Fulfillment
of the Requirements

for the Degree
Doctor of PHILOSOPHY

by

Glenna M. Billingsley, M. Ed.

San Marcos, Texas
August 2007
COPYRIGHT

by

Glenna M. Billingsley

2007
ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to those who helped make my dream into a reality. To my professors, my school community, my friends, and my family, please know that I could not have achieved any of this without each one of you.

No one could ever assemble a more awesome committee than mine. Dr. Scheuermann, thanks for never being more than a phone call away. Thank you for your time and patience and for helping me to become a better student, teacher, and person. Dr. Price, thank you for believing in me enough to serve on my committee even though you were already so busy. Dr. Webber, thank you for setting such a high standard and helping me reach it. Dr. Reese, thank you for providing the opportunity to work and learn under you. You have so inspired me.

I would also like to thank my school community for your encouragement and willingness to help that kept me going. I would like to thank my students who participated in my study. Thanks for making me a better teacher.

To the '02 Cohort, I would like to express what a privilege it has been to take this journey together. Special thanks to Dr. Angelina Kiser for your technical assistance and willingness to help. Those were some nice graphs. Thanks to Michael Wilkerson for your technical support and to Elaine Jones and Melinda Base for your friendship.

I would like to thank my family for their constant support and willingness to make huge sacrifices so that I could live this dream. First, I would like to thank Betty for your love, belief in me, your assistance, and unending support. Thanks to the kids who never
complained about my being too busy. Lastly, I would like to thank my mother for your encouragement and support. I love you all.

This manuscript was submitted on May 21, 2007.
TABLE OF CONTENTS

ACKNOWLEDGEMENTS .............................................................................................................................. iv
LIST OF TABLES ......................................................................................................................................... ix
LIST OF FIGURES ....................................................................................................................................... x
ABSTRACT .................................................................................................................................................. xi
CHAPTER 1: INTRODUCTION AND PROBLEM ...................................................................................... 1
   Background ........................................................................................................................................ 3
   Definitions ......................................................................................................................................... 4
   Purpose of the Study ......................................................................................................................... 7
   Research Questions .......................................................................................................................... 7
   Importance Significance .................................................................................................................... 8
CHAPTER 2: REVIEW OF THE LITERATURE .......................................................................................... 9
   Characteristics of Students with Emotional and Behavioral Disorders ............................................ 9
      Behavioral Characteristics ........................................................................................................... 10
      Academic Characteristics .......................................................................................................... 12
      Relationship between Academic Performance and Behavior .................................................... 16
   Research on Academic Interventions for Students with EBD ......................................................... 17
   Effective Instructional Practices for Students with Disabilities ....................................................... 19
      Teacher-Mediated Intervention .................................................................................................... 21
      Computer-Assisted Instruction ................................................................................................. 26
Role of Student Preference in Academic and Behavioral Performance ........................................................................ 32

CHAPTER 3: METHODOLOGY ................................................................................................................................. 34

Participants and Setting ........................................................................................................................................ 34

Participants ......................................................................................................................................................... 35

Students .............................................................................................................................................................. 35

Setting ................................................................................................................................................................. 39

Research Design .................................................................................................................................................. 43

Dependent and Independent Measures ................................................................................................................ 46

Instrumentation .................................................................................................................................................. 52

OdysseyWare® .................................................................................................................................................. 52

Procedure .......................................................................................................................................................... 54

Data Collection ................................................................................................................................................ 57

Data Analysis ................................................................................................................................................... 58

CHAPTER 4: RESULTS ............................................................................................................................................ 62

Academic Measures .......................................................................................................................................... 62

Wide Range Achievement Test (WRAT-3) Scores - Pretest ................................................................................ 62

Baseline Phase .................................................................................................................................................. 67

Intervention Phase ........................................................................................................................................... 75

Best Treatment Phase ..................................................................................................................................... 87

Post-Instruction Probe .................................................................................................................................... 88

Wide Range Achievement Test (WRAT-3) Scores - Post Test .......................................................................... 90

Interobserver Agreement .................................................................................................................................. 94
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Incomplete Data</td>
<td>96</td>
</tr>
<tr>
<td>Student Preference Measures</td>
<td>97</td>
</tr>
<tr>
<td>Behavioral Measures</td>
<td>104</td>
</tr>
<tr>
<td>CHAPTER 5: DISCUSSION</td>
<td>125</td>
</tr>
<tr>
<td>Data Summary and Discussion</td>
<td>126</td>
</tr>
<tr>
<td>Research Question One</td>
<td>129</td>
</tr>
<tr>
<td>Research Question Two</td>
<td>131</td>
</tr>
<tr>
<td>Research Question Three</td>
<td>133</td>
</tr>
<tr>
<td>Conclusions</td>
<td>137</td>
</tr>
<tr>
<td>Limitations</td>
<td>138</td>
</tr>
<tr>
<td>Implications for Practice</td>
<td>139</td>
</tr>
<tr>
<td>Future Research</td>
<td>140</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>143</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td><em>School Demographic Information</em></td>
<td>35</td>
</tr>
<tr>
<td>Table 2</td>
<td><em>Student Demographic Information</em></td>
<td>37</td>
</tr>
<tr>
<td>Table 3</td>
<td><em>Randomization of Weekly Instructional Method per Period</em></td>
<td>56</td>
</tr>
<tr>
<td>Table 4</td>
<td><em>Pretest WRAT-3 Scores</em></td>
<td>63</td>
</tr>
<tr>
<td>Table 5</td>
<td><em>WRAT-3 Pretest Raw Score and Absolute Score Data</em></td>
<td>65</td>
</tr>
<tr>
<td>Table 6</td>
<td><em>Correlation of Math Objective to WRAT-3 (Blue) Question’s Number</em></td>
<td>68</td>
</tr>
<tr>
<td>Table 7</td>
<td><em>Analysis of Missed Questions by Individual Students</em></td>
<td>70</td>
</tr>
<tr>
<td>Table 8</td>
<td><em>Percentage of Correct Responses on Baseline Curriculum-Based Assessments</em></td>
<td>73</td>
</tr>
<tr>
<td>Table 9</td>
<td><em>Number of Items Correctly Answered per Objective per Student across Baseline Tests</em></td>
<td>74</td>
</tr>
<tr>
<td>Table 10</td>
<td><em>Mean Scores for Conditions and Score for Best Treatment Phase</em></td>
<td>88</td>
</tr>
<tr>
<td>Table 11</td>
<td><em>Comparison of Baseline Scores to Post-Instruction Probe</em></td>
<td>89</td>
</tr>
<tr>
<td>Table 12</td>
<td><em>Comparison of Pretest and Post-Test WRAT-3 Scores</em></td>
<td>91</td>
</tr>
<tr>
<td>Table 13</td>
<td><em>Student Preference Survey Results</em></td>
<td>99</td>
</tr>
<tr>
<td>Table 14</td>
<td><em>Behavior Data by Student and Condition</em></td>
<td>106</td>
</tr>
<tr>
<td>Table 15</td>
<td><em>Individual Student Behavior Data by Condition</em></td>
<td>111</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>Clay's Data Graph</td>
<td>78</td>
</tr>
<tr>
<td>2</td>
<td>Crane's Data Graph</td>
<td>78</td>
</tr>
<tr>
<td>3</td>
<td>Lupita's Data Graph</td>
<td>79</td>
</tr>
<tr>
<td>4</td>
<td>Thaddeus' Data Graph</td>
<td>79</td>
</tr>
<tr>
<td>5</td>
<td>Manny's Data Graph</td>
<td>80</td>
</tr>
<tr>
<td>6</td>
<td>Bryan's Data Graph</td>
<td>80</td>
</tr>
<tr>
<td>7</td>
<td>Chad's Data Graph</td>
<td>81</td>
</tr>
<tr>
<td>8</td>
<td>Hank's Data Graph</td>
<td>81</td>
</tr>
<tr>
<td>9</td>
<td>Junior's Data Graph</td>
<td>82</td>
</tr>
<tr>
<td>10</td>
<td>Tyrene's Data Graph</td>
<td>82</td>
</tr>
<tr>
<td>11</td>
<td>Mean Scores for Conditions</td>
<td>86</td>
</tr>
</tbody>
</table>
ABSTRACT

A COMPARISON OF THREE INSTRUCTIONAL METHODS FOR TEACHING MATH SKILLS TO SECONDARY STUDENTS WITH EMOTIONAL/BEHAVIORAL DISORDERS

by

Glenna M. Billingsley, M.Ed.

Texas State University-San Marcos

SUPERVISING PROFESSOR: BREND A K. SCHEUERMANN

The purpose of this study was to determine the most effective instructional method for teaching mathematics to secondary students with emotional and behavioral disorders. A single-subject research design was utilized to compare three instructional methods: direct teach, computer-assisted instruction, and a combination of those methods. While the combined method was found to be more effective for some learners, it was found that other variables affected learning for these students as much as instructional methodology. Student preference for these methods was also investigated as was the instructional method associated with higher rates of appropriate behavior.
INTRODUCTION AND PROBLEM

Statement of the Problem

According to the Twenty-sixth Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Improvement Act (U.S. Department of Education OSEP, 2006), which analyzed special education data for the 2002-2003 school year, 479,653 students ages 6 to 21 qualified for special education services under the Individuals with Disabilities Education Act (IDEA) as students with an emotional disturbance. These students comprised 8.1% of students with disabilities and 0.9% of all students enrolled (U. S. Department of Education, 2004). The educational prognosis for students with emotional and behavioral disabilities (EBD) is poor. The manifestations of this disability negatively affect academic and social progress. Compared to other populations of students with disabilities, students with EBD have higher rates of academic failure, suspension, and drop-out (Kauffman, 2005; Walker, Ramsey, & Gresham, 2004). Landrum, Brubaker, Katsiyannis, & Archwamety (2004) assessed the dropout rate of students with EBD at 43% to 56%. Given the high probability for a shortened educational experience, it is critical that the time in which these students are actually in a learning environment be spent utilizing practices that research has shown to be most effective.
Extensive research exists on instructional best practices for most disabilities. However, there is a dearth of knowledge for teaching academics to students with EBD; often, strategies and methodologies are extrapolated from research on other populations (Lewis, Hudson, Richter, & Johnson, 2004). According to Ruhl and Berlinghoff (1992), the wide variability of academic and social behaviors of students with EBD create a need to continue research with this population instead of concluding that certain similarities to students with learning disabilities (LD) justify similar teaching methods. Additionally, instructional methods are often selected on the basis of tradition, availability or convenience as opposed to research-based practices (Heward, 2003).

Public Law 107-110, the No Child Left Behind Act (NCLB), mandates educational practices that are supported by “scientifically-based research.” Rigorous, scientifically researched-based best teaching practices, not faddish, ephemeral, philosophies, is the directed standard. According to the No Child Left Behind Act, scientifically-based research is research that involves the application of rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs. Under the parameters of this legislation, scientifically-based research would include research that:

- Employs systematic, empirical methods;
- Involves rigorous data analysis;
- Relies on measurements or observational methods;
- Is evaluated using experimental or quasi-experimental designs;
- Ensures that experimental studies are presented in sufficient detail and clarity to allow for replication; and
- Has been accepted by a peer-reviewed journal or approved by a panel of independent experts (NCLB, Section 789(37)).

Of the many methods of delivering instruction to students including direct teach, cooperative learning groups, peer tutoring, and computer-assisted instruction, studies have shown direct teach to be the preferred method of teaching students with disabilities, including students with EBD (Scheuermann & Hall, 2008). As computer technology has become more available, teachers have been urged to integrate technology into their lessons. Computers in particular play a prominent role in the classroom with a wealth of educational software available across curricular areas. The use of computers for instruction, called computer-assisted instruction (CAI) is an appealing concept, but one that has limited efficacy support for students with EBD. Thus, a conflict exists between what research has shown to be effective for students with disabilities and what teachers actually practice in the classroom. Because federal mandates call for educational practices that are scientifically determined to be best practices, it is necessary to evaluate the effectiveness of computer-based instruction prior to its becoming a commonly practiced form of instruction with this population.

**Background**

In 2003, the assistive technology department of a large, central Texas school district received a $500,000 Technology Infrastructure Foundation (TIF) Discovery grant that provided computer stations loaded with special curriculum software to several high school and middle school self-contained, special education classrooms for students with EBD. The packaged curriculum, called OdysseyWare®, contained most of the required and elective courses for middle and high school. OdysseyWare® was selected over other
software curricula because it aligned with state curriculum standards. Texas Essential Knowledge and Skills (TEKS), and because it can be tailored to the unique instructional needs of students with disabilities.

Teachers on campuses utilizing the OdysseyWare® used the computer-assisted software in a variety of ways. Some teachers discontinued all forms of direct teach and used the computers for all instruction. Others ignored the expensive technology and continued to teach in a more traditional format. Still others combined the two methods, using teacher-led lessons followed by assignments completed on the computer. With the increase of technology in classrooms, and given the pressing need for effective instruction for students with EBD, it is necessary to evaluate the efficacy of computer-assisted instruction compared to other instructional approaches for students who struggle academically.

**Definitions**

Following are definitions for terminology used in the present study:

*Direct Teach*

Direct teach, also known as teacher-mediated instruction or direct instruction, is the systematic approach to teaching new skills or concepts to students. Instructional activities are sequentially designed with the purpose of increasing academic achievement and emphasize teacher behaviors and variables related to classroom structure. In the direct teach model, specific teacher behaviors are employed in order to attain desired learning and behavioral outcomes (Scheuermann & Hall, 2008).
Computer-Assisted Instruction

Computer-assisted instruction uses instructional software to teach and/or practice specific skills and concepts, usually focusing on a specific content area and grade range. Instructional software is in contrast to tool software that can be used across curricular and content areas. Tool software includes word processors, concept processors such as outliners or graphic organizers, newsletter programs, spreadsheets and databases, audio-video editors, multi-media presentation programs, and web browsers.

OdysseyWare®

*OdysseyWare®* is a multi-media-enhanced CAI curriculum published by Pathway Publishers®. *OdysseyWare®* includes diagnostic assessment features, individualized, self-paced instruction, and utilities for teachers to manage the instructional sequence and presentation. Formerly published by Switched-On Schoolhouse, it is often used as a curriculum for students who are home-schooled because it offers a full range of core subjects and required electives (J. McSorley, personal communication, October 7, 2005).

Emotionally Disturbed

Emotional Disturbance (ED) is one of the twelve disabilities for which students may receive special education and support services under the Individuals with Disabilities Education Improvement Act (IDEIA). IDEIA defines Emotional Disturbance as:

a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree, which adversely affects educational performance: (a) an inability to learn which cannot be explained by intellectual, sensory, or health factors; (b) an inability to build or maintain satisfactory
interpersonal relationships with peers and teachers; (c) inappropriate types of behaviors or feelings under normal circumstances; (d) a general pervasive mood of unhappiness or depression; or (e) a tendency to develop physical symptoms or fears associated with personal or school problems. This term includes schizophrenia, but does not include students who are socially maladjusted, unless they have a serious emotional disturbance (Code of Federal Regulations, Title 34, Section 300.7(b)(9).

**Emotional Behavioral Disorders**

Emotional/Behavioral Disorders (EBD) is the preferred term by practitioners in the field of behavioral disorders to refer to students labeled ED (Jones, Dohrn, & Dunn, 2004). EBD also refers to other students who have emotional and/or behavioral difficulties that interfere with school success but who may or may not have been formally identified. EBD is not a formal diagnosis or classification system, but rather is used to refer to a broad population of students, many of whom have diagnoses such as attention deficit-hyperactivity disorder, anxiety disorders, bi-polar disorder, depression, or who exhibit other disorders of conduct that interfere with the student’s successful academic, social, or personal adjustment.

**WRAT-3**

The Wide Range Achievement Test® Third Edition is a standardized, psychometric test that provides norm-referenced information about academic ability and problem-solving skills. The WRAT-3 is often used to assess academic achievement in reading, spelling, and arithmetic. It is also useful for identifying specific curricular and instructional needs for individual students.
Purpose of the Study

The purpose of this study is to determine the most effective instructional method for teaching mathematics to secondary students with EBD. The three instructional methods to be compared are teacher-directed instruction (direct teach), computer-assisted instruction, and a combined approach. To comply with the federal mandate of NCLB, the instructional methods used to educate students must be based on systematic, scientific research; currently there is insufficient information on which to base instructional decisions in math for students with EBD. This study will provide information not only to school districts that are facing the research-to-practice dilemma, but will contribute to the knowledge base in the field of EBD. Establishing effective instructional methods is critical for any population, but particularly for students with EBD, given the dismal academic outcomes for this population.

Research Questions

Three research questions guide this study:

1. Which instructional method is most effective for teaching mathematics to secondary students with emotional and behavioral disorders – direct teach, computer-assisted instruction, or a combination of these two approaches?

2. Since preference is an important consideration for reluctant learners, which of these three methods do these students prefer?

3. Which instructional method is associated with higher rates of appropriate behavior?
Importance Significance

This study’s importance lies in the contribution it will make in three distinct areas. First, school districts require current, research-based information upon which to base decisions regarding the allocation of resources. By increasing the knowledge base regarding best practices in instructional methods for students with EBD, districts can make informed decisions regarding instructional spending and professional development for teachers. Second, knowing the efficacy of instructional methods for teaching students with EBD is vitally important to students whose learning is often impeded by the manifestations of their disability. The time actually spent in learning endeavors cannot be squandered using methodologies that lack empirical evidence of effectiveness. Finally, the federal mandate of NCLB requires educational practices that are supported by rigorous, scientifically based research. Thus, this study is an important contribution to the research base in instructional practices for students with EBD.
CHAPTER 2

REVIEW OF THE LITERATURE

While federal mandates impose standards of research-based best practice and list improvement in academic achievement, particularly mathematics, as a national priority, few empirical studies provide guidance in this direction for certain student populations. According to Mooney, Epstein, Reid and Nelson (2003), we know little more about educating students with emotional and behavioral problems than we did twenty years ago. Further, a gap exists between what is known in the field of special education and what is practiced at the classroom level (Ruhl & Berlinghoff, 1992).

Characteristics of Students with Emotional and Behavioral Disorders

Students with emotional and behavioral disorders (EBD) possess behavioral and academic characteristics that interfere with successful school and vocational outcomes and that necessitate intervention efforts. While a causal factor between behavior problems and academic deficits has not been determined, there is an obvious relationship between the variables (Ruhl & Berlinghoff, 1992). Yet, despite the dismal academic and social outcomes for these students, there are few investigational studies that involve this population. Mooney, Epstein, Reid, and Nelson (2003) found that the number of experimental studies involving the education of students with EBD steadily declined
from 1980 to 1999 and that a greater percentage of the studies were conducted in either alternative settings or clinics, with a corresponding decline of research in special education classroom settings in public schools.

Currency is always an issue in research. Much of the research on academic achievement of students with EBD is not recent. Trout, Nordness, Pierce, and Epstein (2003) noticed that following a dramatic surge in publications assessing academic status of students with EBD from 1961-1970, a steady decline occurred in the decade from 1991-2000. In fact, the number of studies specific to academic achievement for students with EBD for each of those years has ranged from zero to five.

**Behavioral Characteristics**

Students with emotional and behavioral disabilities exhibit a wide range of behaviors. Kauffman (2005) described two primary dimensions or broadband problems of disordered emotions and behavior: externalizing and internalizing behavior. Externalizing behaviors include aggression, impulsivity, disobedience, and delinquency. Internalizing behaviors are characterized by depressive affect, anxiety, and social withdrawal. Kauffman also referred to highly specific behaviors such as hyperactivity, mental disorders, and major depressive disorders as narrowband problems.

The following behaviors are typical of students with EBD: aggressiveness, defiance, noncompliance, arguing, tantrums, patterns of lying and stealing, lack of self-control, failure to assume responsibility, withdrawing, compulsive or obsessive behaviors, apathy, anxiety, depression, irritability, phobias, being overly sensitive, feelings of inferiority, and avoidance behaviors. Any of these behaviors would undoubtedly interfere with students' learning (Algozzine, Serna, & Patton, 2001). While
these behaviors may be observed in all children at some point, they differ for students with EBD in the frequency, duration, and intensity relative to their peers (Smith, Polloway, Patton, & Dowdy, 2006).

Behavioral characteristics differ somewhat for elementary and secondary students (Lane, Carter, Pierson, & Glaeser, 2006). Adolescents experience relationship problems, inappropriate behaviors, and social incompetence, but the manifestations of these problems take different forms from their elementary counterparts. According to these authors, assessment measures for adolescents should consider differences that include truancy and maladaptive social behaviors unique to adolescence.

Through the National Longitudinal Transition Study – 2 (NLTS2) adolescents with EBD were found to miss an average of 15.3 days of school per year, another factor that affects academic achievement. Further, higher absenteeism was found to be significantly associated with lower scores in math calculation and problem solving (Wagner, Newman, Cameto, Levine, & Garza, 2006). Lane, Carter, Pierson, and Glaeser (2006) found that students with EBD had over twice as many absences and disciplinary contacts and almost three times as many negative narrative comments written into their cumulative folders relative to students identified with a learning disability. This is consistent with the NLTS2 finding that 40% of students with EBD had difficulty controlling their classroom behavior versus only 20% of students in other disability groups.

The NLTS2 also reported that students with EBD are more likely to be suspended or expelled than students in all other disability categories. In one school year, 63% experienced disciplinary action including suspensions and expulsions with an average of
seven disciplinary incidents per student. According to this longitudinal survey, 73% of students with EBD have been suspended or expelled at some point during their school careers.

*Academic Characteristics*

According to the Individuals with Disabilities Education Improvement Act, 20 U.S.C. § 300.8 (c) (4) (2004), the first criterion in the definition of Emotional Disturbance (ED) is “an inability to learn that cannot be explained by intellectual, sensory, or health factors.” While most secondary students with EBD take the same type academic courses as other students, they are less likely to take these courses in general education settings than students with all other disabilities and they are less likely to perform as well. Wagner and Cameto (2004), utilizing data from NLTS2, found that while 88% of adolescents with other disabilities took some coursework in general education, only 78% of students with EBD took at least one course in general education. Further, while most students with EBD are closer to grade level in reading and math than youth with other disabilities, they are more likely to receive poor grades. Fourteen percent of secondary students with EBD receive mostly Ds or Fs, while only 8% of youth with other disabilities receive those failing grades.

Many other studies document the academic deficiencies of students with EBD. Cullinan (2002) found that most students with EBD performed more than one year below grade level in academic achievement. Nelson, Benner, Lane, and Smith (2004) found that more than 80% of adolescents scored below the mean of the norm group in the broad reading, broad writing, and broad math clusters on a standardized achievement battery. In a study of 812 elementary and secondary students with EBD, Greenbaum et al. (1996)
found that 58% of students performed below grade level in reading and 93% performed below grade level in math as measured by the Wide Range Achievement Test (WRAT). In a literature survey by Trout et al. (2003), 91% of the students were found to perform below their grade level or years behind their peers on academic tasks. Overall, studies show that academic achievement of adolescents with EBD is not commensurate with their chronological age (Epstein, Kinder, & Bursuck, 1989; Kauffman, 2005).

According to the NLTS2, the average grade point average for secondary students with EBD was 2.1 on a 4.0 scale. Further, 74% of students reportedly failed at least one course, higher than any other disability group. This study also found that 37.7% of students with EBD repeated a grade at some point in their educational career, higher than any disability group except students with mental retardation (Wagner, Newman, Cameto, Levine & Marder, 2003). These findings were consistent with an older study completed by the Chesapeake Institute (1994) on behalf of the Office of Special Education Programs of the Department of Education. Students with EBD had lower grades, failed more courses, were retained at grade level more often, and more frequently failed minimal competency examinations than did students with other disabilities. This study also found that high school students with EBD had an average grade point average of 1.7, on a 4.0 scale, compared to 2.0 for all students with disabilities and 2.6 for all students without disabilities. Forty-four percent of students with EBD received one or more failing grades in their most recent school year compared to 31% for all students with disabilities. Of those who took minimum competency tests (22% were exempted), 63% failed some part of the test.
Findings of studies consistently maintain that students with EBD perform less well academically than their peers without disabilities (Nelson, Brenner, Lane, & Smith, 2004). Coleman (1996) cited a review of 25 studies that found that the majority of students with EBD fall within the low average range of cognitive ability. In fact, one study by Mastropieri, Jenkins, and Scruggs (1985) found the average IQ ranged from 89.5 in public schools to 96.5 in outpatient, psychiatric settings. Nelson, Brenner, Lane, & Smith further stated that compared to students with other disabilities, students with EBD perform better academically only when compared to students with mental retardation.

Students with EBD perform similarly to their peers with learning disabilities (LD) in arithmetic and written expression and similar to students with Attention Deficit Hyperactive Disorder in reading, arithmetic, and written expression (Trout et al., 2003). According to a longitudinal study by Anderson, Kutash, and Duchnowski (2001), the major difference between students with EBD and their LD peers is that the academic achievement deficits experienced by students with EBD remained stable or worsened over time, whereas students with LD showed some improvement over the five year study.

Some students with EBD also have an identified specific learning disability (LD). Mattison, Hooper, and Glassberg (2002) found the rate of comorbidity between emotional disturbance and a LD to be 53.2%, although the researchers stated the rate may be much higher, as the learning disability often goes undiagnosed. The presence of learning disabilities, diagnosed or undiagnosed, may partially explain the high rate of academic failure among students with EBD.
The combination of academic deficits and associated difficulties that typifies students with EBD is a strong predictor of problems throughout life (Scott & Shearer-Lingo, 2002). According to the 26th Annual Report to Congress (U. S. Department of Education, 2005), during the 2001-2002 school year, only 38.8% of students labeled Emotionally Disturbed (ED) left high school with a regular diploma. Of the twelve eligibility categories of students receiving special education services, those labeled ED had the lowest rate of graduation. The NLTS2 reported that while 72% of respondents with all disabilities graduated, only 56% of students with EBD did so.

Math Performance of Students with EBD

In 1994, the 103rd U.S. Congress published Goals 2000: Educate America Act of 1994, which established the nation’s educational goals for the 21st century. The fifth goal reads, “By the year 2000, United States students will be first in the world in mathematics and science achievement.” This ambitious goal includes students identified with EBD. Yet, according to Bottge, Rueda, and Skivington (2006), 56% of students with EBD are at least three grade levels behind their grade placement in mathematics.

Epstein, Kinder, and Bursuck (1989), and Reid, Gonzalez, Nordness, Trout, and Epstein (2004) found that students with EBD scored lower in mathematics than in reading. In a study by Greenbaum et al. (1996), 97% of 12 to 14 year-olds with EBD performed below grade level in mathematics, whereas only 75.4% of this same cohort was found to be below grade level in reading. A study by Nelson, Benner, Lane, and Smith (2004) extended this line of inquiry. These authors reported that deficits in mathematics appeared to be even more resistant to change than reading and written expression, and those deficits in mathematics increased with age.
Research has clearly demonstrated a relationship between low academic achievement and problem behavior. According to Walker, Ramsey, and Gresham (2004), “As a rule, antisocial students [which includes students with EBD as well as students who are socially maladjusted] make relatively poor adjustments to the demands of schooling and to instructional environments controlled by teachers” (p. 18). Trout and colleagues (2003) summarized 39 years of research that establishes the reciprocal relationship between academic underachievement and problem behavior, a relationship that has both short- and long-term impact on student outcomes. The origins of this relationship, however, have yet to be established.

Some researchers insist that behavior issues lead to low academic performance. In support of this position, Walker, Ramsey, and Gresham (2004) explain that students with behavior problems disrupt the instructional process and are placed in settings other than the regular classroom as a result. In these segregated settings, students socialize each other to higher levels of misbehavior than would otherwise be the case. These authors also found that there was a significant reduction in academic engaged time, averaging 60 to 70% of the levels of on-task time observed in general education classes. Low levels of engagement with academic tasks, poor attendance, and weaker academic skills, combined with homogenous grouping of students with problematic behavior create poor conditions for improving academic or behavioral skills. Carr and Punzo (1993) and Scott and Shearer-Lingo (2002) confirm those findings by presenting evidence that effective instruction and instructional strategies have been shown to improve academic and behavioral outcomes.
Others researchers maintain that low academic success leads to behavior problems. Scott, Nelson, and Liaupsin (2001) suggest that academics have become an aversive situation for some students with challenging behaviors and therefore students tend to engage in inappropriate behaviors during class to escape the demands of the task. Gunter, Denny, & Jack (1993) speculate that academic failure leads to the development of maladaptive behaviors, which often result in the student being removed from aversive stimuli.

Regardless of which variable precipitates the other, Sutherland and Wehby (2001) point out that high rates of problematic behavior result in lowered rates of instruction; when effective instruction is in place, rates of problem behavior decrease. However, these authors found that teachers of students with EBD did not consistently utilize effective teaching practices. Rarely were validated practices used and evidence suggests that teachers provided less instruction to students who exhibited challenging behaviors. This illustrates other researchers' claims that students with externalizing behaviors such as aggression, defiance, and acting-out were negatively affected academically more often than students with internalizing behaviors (e.g. anxiety, withdrawal, depression) (Barriga, Doran, Newell, Morrison, Barbetti, & Robbins, 2002; Epstein, Kinder, & Bursuck, 1989; Nelson, Benner, Lane & Smith, 2004).

Research on Academic Interventions for Students with EBD

Few experimental studies specifically target academic interventions for EBD populations (Bottge, Rueda, & Skivington, 2006; Mooney, Epstein, Reid, & Nelson, 2003). While many studies have established the relationship between students with EBD and academic underachievement, fewer studies have focused on academic interventions
for these students. Even fewer empirical studies have targeted academic interventions in mathematics for this population (Gunter & Denny, 1998; Hodge, Riccomini, Buford, & Herbst, 2006; Ruhl & Berlinghoff, 1992). Pierce, Reid, and Epstein (2004) stated that there is such a small database on academic interventions with this population that it is difficult to recommend sound educational practices.

Epstein, Kinder, and Bursuck (1989) suggest that research on classroom instruction in general has identified a number of instructional variables that enhance the performance of students with EBD. These include increasing time for instruction, presenting material in a structured and systematic fashion, reviewing previously taught concepts daily, frequent questioning, high levels of opportunities for responding, providing positive and corrective feedback, and encouraging independent practice. Sutherland and Wehby (2001) extended this work showing that increased rates of opportunities to respond (OTR) and interaction with the instruction resulted in higher task engagement and academic achievement, as well as lowered rates of inappropriate behaviors in the classroom.

Scott and Shearer-Lingo (2002) found that successful academic outcomes are related to instruction that is delivered at the student's level, provides repeated practice opportunities, maintains direct teacher-student interaction, and actively involves students monitoring their own progress. Further, they found that the more effective the instruction, the more powerful the effect on behavior. The key to facilitating success with these students is to create the opportunities for success with instructional tasks each day, as success is a predictable, natural reinforcer.
Teachers often make instructional decisions based on what is convenient or popular. However, even when teachers wish to use instructional strategies that have gained professional acceptance, there are often conflicting reports as to the effectiveness of various approaches. According to Lloyd, Forness, and Kavale (1998), new interventions should be systematically examined to determine benefit for students prior to actual implementation.

There is even less research on academic interventions for students with EBD specific to math instruction. Pierce, Reid, and Epstein (2004) found only four studies in the previous seven years that attempted to improve the math skills of students with EBD. Mooney, Epstein, Reid, and Nelson (2003) identified only 55 studies on academic interventions for students with EBD over the past 30 years. Of these, only 27 focused on mathematics. Further, despite the emphasis on application of mathematics and problem solving by content organizations such as the National Council of Teachers of Mathematics (2003) and Goals 2000: Educate America Act of 1994, all but one of the 27 studies focused narrowly on computation skills.

Effective Instructional Practices for Students with Disabilities

Reviews of literature involving specific techniques used to produce improved academic outcomes for students with disabilities are scarce; they are almost non-existent for students specifically with EBD. Lewis, Hudson, Richter, and Johnson (2004) identified the following practices as those that are research-supported in producing desired academic outcomes. Teacher praise and reinforcement are the most effective practices described in the literature. Second, altering instructional methods and materials so that high levels of correct academic responding is achieved increases on-task
engagement. Third, implementing the tenets of positive behavior support, as defined by the Office of Special Education Programs (OSEP), has been shown to improve learning and social outcomes.

Heward (1997) identified four instructional strategies that have been field tested and validated to demonstrate effectiveness across a range of subject areas. Those strategies include response cards or signs that can be used by students to respond to questions or problems presented by the teacher. This allows for practice for all students simultaneously rather than the teacher calling on one student at a time. Second, Heward recommended using a guided note-taking format as opposed to having students select what information is deemed important. Third, providing immediate feedback and error correction during the acquisition phase of learning ensures students do not practice incorrectly. The final strategy for improving academic outcomes is to assist students in building fluency. This involves providing multiple opportunities to practice concepts presented.

Forness, Kavale, Blum, and Lloyd (1997) performed a meta-analysis of special and related education services. In this study, an effect size (ES), or relative power, was determined for several interventions and procedures. Effect size is a standardized scale that ranges from zero, meaning no effect, to one, which indicates a strong effect, intended to quantify the effectiveness of an intervention. Therefore, these values allow for direct comparison across different studies that also use Cohen's effect sizes. According to Cohen, an ES of .8 or greater is considered to be largely effective, an ES of .5 is considered to have a medium effect, whereas an ES of .2 or less is considered a small effect.
Some interventions or procedures, such as direct instruction were found to be quite efficient. Overall, direct instruction was found to have an ES of .84; however, direct instruction had higher effects for reading than for mathematics. Other interventions, such as computer-assisted instruction, peer-tutoring and reducing class size, show promising efficacy. Computer-assisted instruction had an ES of .52, peer tutoring was .46, and smaller class size had an ES of .31. Interventions such as the Feingold diet, a diet that restricts artificial coloring, flavors, and sweeteners, with an ES of .12 and perceptual-motor training (ES = .08) demonstrate little evidence that these methods should be a part of educational programming for students with EBD.

Teacher-Mediated Intervention

One technique that has been extensively researched and has been found to improve students' academic performance is teacher-mediated, or teacher-directed intervention (Lewis, Hudson, Richter, & Johnson, 2004; Pierce, Reid, & Epstein, 2004). Teacher-directed instruction is instruction delivered by the teacher that is highly organized, task-oriented, and presented in a clear, direct manner to promote students understanding (Ellis & Worthington, 1994). Known by names such as direct instruction, active teaching, or direct teach, it is effective because it incorporates features that address learning and behavioral characteristics necessary for learning, but which students with EBD lack (Scheuermann & Hall, 2008).

Direct Teach

According to Ellis and Worthington (1994), presenting information in a teacher-directed manner is a critical principle for effectively teaching students with special learning needs. Key components of direct teach include structure, sequencing and pacing
of instruction, opportunities for corrective feedback, and opportunities to practice newly acquired skills.

Direct teach is characterized by:

- organization of instruction around specific instructional objectives;
- large-group or small-group instruction;
- structure, clarity, and repetition;
- explanation supported by demonstration;
- high levels of student engagement;
- mastery learning – students are expected to practice skills independently only after they have demonstrated minimum levels of mastery (e.g., accuracy in responding) in performing those tasks under teacher supervision (Scheuermann & Hall, 2008).

The following steps are recommended in a direct teach model:

1. Gain the attention of the learners.
2. Review previously learned material that is relevant to the new information that will be presented. Check for understanding of previous material and assist students with making connections prior learning. Reteach any information necessary, and address fluency and maintenance of learning.
3. State the goal, objective, and rationale for new learning.
4. During this acquisition stage of learning, present new content by breaking the task down into smaller components and constantly checking for understanding and providing feedback and reteaching for errors.

5. As a part of introducing new content, simultaneously model the skill using multiple examples and demonstrations of the skill.

6. Provide practice that is guided by the teacher to ensure students have achieved at least 80% mastery of the new material.

7. Provide unprompted practice prior to allowing students to work independently. This provides for minimal errors during independent practice.

8. Provide repeated opportunities for independent practice to build mastery and automaticity and to move students from acquisition to fluency, maintenance, and generalization stages of learning (Scheuermann & Hall, 2008).

The Forness, Kavale, Blum, and Lloyd (1997) study found direct instruction, or direct teach, to be largely effective with special populations, with an effect size of .84; however when mathematics was specifically analyzed, the effect size was .50. Gunter, Coutinho, and Cade (2002) found that classroom factors that were most strongly linked to academic gains with EBD populations were those that contained critical components of direct teach. These included gaining students’ attention, presenting the objective and relevance of the information, reviewing past learning, demonstrating new information,
providing guided assistance on new information, reviewing the lesson, and evaluating students’ performance toward mastery.

Direct teach does incorporate the validated strategies necessary for teaching students with disabilities. It provides practice guided by the teacher with feedback to facilitate errorless learning, creating many opportunities for students to interact with the instructional stimuli, and opportunities for students to practice which builds fluency and assures mastery (Heward, 1997). Educators who teach academic and cognitive skills directly and systematically are using an intervention that has strong research support in terms of producing better educational outcomes (Ellis, Worthington, & Larkin, 1994; Lloyd, Forness, & Kavale, 1998).

Wilson and Sindelar (1991) conducted a study of three conditions under which elementary students with learning disorders best learned to solve math word problems. Students were taught to solve addition and subtraction word problems using a specific strategy and graduated difficulty of sequencing, using a strategy only, and using only sequencing whereby the level of difficulty was systematically elevated. While each condition was a teacher-mediated form of instruction, directly teaching a strategy and providing students with graduated sequencing significantly exceeded either of the other conditions in isolation. The implication of this study is that merely delivering material in proper sequence is a necessary but not a sufficient component of teaching students with learning difficulties or EBD.

A 2004 meta-analysis with 30 students incorporating direct teach with respect to the academic functioning of students with EBD yielded positive academic outcomes for the students (Pierce, Reid, & Epstein, 2004). Ninety percent of the participants in the
studies made statistically significant academic gains, particularly in math and reading. While this study is encouraging, the authors underscore the need for further research into effective academic interventions with this population, as generalization is cautioned due to the relatively small number of studies.

**Opportunities to respond.** Increasing the number of opportunities to correctly respond during instruction has been identified as one of the most effective teaching practices for students with EBD. It is one of the bedrock components of direct teach. Lewis, Hudson, and Richter (2004) identified high rates of opportunities to respond during instruction as one of four research-based practices that has been shown to increase academic achievement and decrease inappropriate behavior. Sutherland and Wehby, (2001) reviewed literature and examined the effect of increased opportunities to respond to academic requests (OTR) on academic and behavioral outcomes of students with EBD. The literature suggests that by increasing the rates of opportunities to respond (OTR) academic outcomes and task engagement increases, and inappropriate and disruptive behavior decreases.

According to the Council for Exceptional Children (1987) and Gunter, Hummel, and Venn (1998), an optimal rate of OTR for new material is 4 to 6 responses per minute with 80% accuracy; for material being reviewed, teachers should elicit 8 to 12 responses per minute with 90% accuracy. Sutherland and Wehby (2001) further discovered that despite the positive outcomes associated with high levels of OTR, students with EBD do not receive OTR at a desired rate. Heward (1997) suggests response cards, signs, or items that students can use to indicate their response to the teacher’s question or problem.
Response cards are one strategy that allows teachers to provide these recommended rates of responding.

*Computer-Assisted Instruction*

Perhaps because using technology to teach students is a relatively new concept, literature regarding the efficacy of computer-assisted instruction is sparse (Lloyd, Forness, & Kavale, 1998). Literature pertaining to the use of CAI with special education populations is even less plentiful.

*Computer-Assisted Instruction*

Research conducted prior to 1997 showed that students used technology mostly for keyboarding, drill and practice, and educational games (President’s Committee of Advisors on Science and Technology, 1997). However, more recent reports suggest that as more teachers have become technologically literate and there is greater access to computers, there is more infusion of technology into lesson delivery. This ranges from educators using multimedia to enhance a lecture to self-paced study using comprehensive online or CD-ROM courseware programs, as is the case with OdysseyWare®.

There is evidence of positive relationships between computer use and academic and behavioral achievement. Xu, Reid, and Steckleberg (2002) reviewed empirical studies that assessed the efficacy of technology as an instructional tool for students with Attention Deficit/Hyperactivity Disorder (ADHD). Overall, they found that computer-assisted instruction provided a highly stimulating instructional environment where students received frequent and immediate performance feedback, instant reinforcement, and continuous opportunities to respond to academic stimuli, elements that have been shown to improve performance of children with ADHD according to Barkley (1998). Xu,
Reid. and Steckleberg (2002) found that curriculum programs that provide instructional modifications such as step-by-step elaboration of tasks, models of task completion, and concrete examples further improve academic performance. While this study was specifically focused on students with ADHD, it should be noted that there is considerable overlap between this condition and students who are labeled EBD (Walker, Ramsey, & Gresham, 2004).

There is research that suggests that using CAI to assist with instruction leads to increased academic achievement. In a five-year longitudinal study conducted by Mann, Shakeshaft, Becker, and Kottkamp (1999), the efficacy of West Virginia's "Basic Skills/Computer Education" program was assessed. The program consisted of providing software that focused on teaching basic skills in reading, language arts, and mathematics for students in kindergarten through fifth grade. Students in kindergarten during the initial year, the 1989-1990 school year, were exposed to the computerized curriculum for five years; students in first grade were exposed to this curriculum for four years; this pattern continued to fifth grade students who received one year of computerized basic skills curriculum. The study found that the more years students were exposed to the program, the more advances in basic skills they made. Hitchcock & Noonan (2000) compared CAI and teacher-facilitated instruction using an adapted alternating treatments design with five preschool children with significant delays in cognition, language, or adaptive behavior skills. They found that CAI was an effective tool for enhancing the learning of academic skills, promoting maintenance of skills, and reinforcing learning through additional practice using a motivating medium. However, they observed that students using teacher-facilitated instruction made significant gains as well. Overall, they
found that the computer was motivating to students and was most effective if utilities could be manipulated to individualize or modify instruction.

Laffey, Espinoza, Moore, and Lodree (2003) conducted a study that compared academic and motivational gains for urban elementary students with behavior problems to students without behavior problems while utilizing interactive computer technology. Regarding motivation, there was no difference between students with and students without behavior problems; both groups were equally motivated by the opportunity to utilize the computer. Likewise, both groups made academic progress; however, the group of students with behavioral problems had significantly higher gain scores although they continued to score below peers without behavior problems. While this study did not include students labeled EBD, it did include students whose behaviors were very similar and showed that students with poor impulse control, non-compliance, and distractibility were successful in an environment using integrated computer technology. According to the authors, the immediate feedback, appropriate cognitive challenge, engaging visuals, and need for focused attention that CAI offers, shows promise for students with behavioral difficulties.

While not conducted specifically with students identified as EBD, Powell, Aeby, and Carpenter-Aeby (2003) conducted a study involving students placed in and alternative education program (AEP) for disruptive behavior. They found that students improved their grade point averages and took more responsibility for their own learning when utilizing a computer-based instructional package called SuccessMaker®. Students performed even better when they used SuccessMaker® and had significant teacher facilitation.
In a meta-analysis of 120 studies, the learning effect of CAI conducted by Fletcher-Flinn and Gravatt (1995), the mean effect size for CAI was .24 for the years 1987-1992 and from 1991-1992 (32 of the 120 studies) the effect size was an average of .33. Although still in the low-moderate range for effect size, these estimates did raise student post-test scores from the 50th to 60th percentile. In 1997, Forness, Kavale, and Blum found a moderate effect size of .52 for computer-assisted instruction in their study of 18 meta-analyses of interventions for students with disabilities.

Shiah, Mastropieri, and Scruggs (1995) reviewed 45 studies from 1981–1994 where CAI was used with students with learning disabilities. Sixteen of these studies investigated increasing math achievement with computer-assisted instruction. The different types of CAI included drill and practice, game-like simulation, tutorials, and interactive videodisk systems. Five of the sixteen studies focused on attitudes toward computers and math achievement. While two of those five reported positive results, the remaining three reported no significant differences. Eight studies investigated some aspect of teaching math computation; these studies yielded ambiguous findings. The three studies that focused on teaching students to solve word problems reported no significant differences among treatment conditions, although there were gains in pre-post tests. It does bear mention that these studies were dated in light of technology advancements beyond drill and practice and games.

However, the authors reported that students enjoyed the use of computers and had positive attitudes toward the academic tasks while they were completing them on the computers. This is an important finding for students who are typically reported to have
poor motivational attitudes toward school and school-related tasks. In summary, students with LD can learn math from computers, though they might not necessarily learn more from using computers than from teacher-provided math instruction.

Lewis and Sugai (1999) reported behavior problems can improve with the use of an appropriate curriculum and when students experience academic success. Fletcher-Flinn and Gravatt (1995) found that the learning advantage offered by CAI was due to high quality instructional design. For example, instructional objectives were clear, instruction was sequenced with feedback, and materials encouraged participation and interactivity. Also, these researchers found a slighter increase in desired outcomes in mathematics than for other subjects, possibly due to individual pacing and drill and practice opportunities that offered immediate feedback.

If a computerized curriculum offers guided, interactive instruction, immediate, corrective feedback during scaffolded practice, and multiple opportunities for practice to build fluency, then computer-assisted instruction is consistent with Heward's (1997) necessary conditions for promoting academic success for students with disabilities.

Math Instruction

Federal and state mandates to increase participation and accountability in mathematics by students with disabilities have spurred organizations such as the National Council of Teachers of Mathematics to consider ways in which these students can be accommodated in rigorous, higher-level math acquisition (National Council of Teachers of Mathematics, 2003). Yet, according to Maccini and Gagnon (2006), no empirical studies to date provide validated and recommended accommodations to assist secondary students with EBD in mathematics. Given the difficulties that many students with EBD
experience in mathematics, it is important to identify instructional practices that contribute to student success in math.

In an investigation of the current status of instructional practices in mathematics for students with EBD, Maccini and Gagnon (2006) found that special education teachers were less familiar with higher-level math knowledge than their general education counterparts; yet general education teachers were less likely to use specific instructional strategies and accommodations. Maccini, Gagnon, Mulcahy, and Leone (2006) made the following recommendations for teaching mathematics to students with EBD: (a) Include advance organizers to help orient students to the lesson and link lessons to student interest and prior knowledge; (b) incorporate principles of direct instruction; (c) use technology and embed math in real-world situations to foster understanding and promote generalization; (d) integrate calculators and include training for using them effectively; (e) utilize a variety of instructional groupings that include whole group, small group, collaborative peer activities, and individual work; (f) incorporate a graduated instructional sequence that progresses from use of concrete objects to abstract representations; and (g) use strategy instruction to facilitate independent learning.

Bottge, Rueda, and Skivington (2006) used a mixed-methods approach to investigate math instruction utilizing Enhanced Anchored Instruction (EAI) with adolescents in a public, charter school for students with behavior problems. EAI involves teaching math concepts in the context of designing and building things. Students scored higher on the tasks that directly assessed concepts taught in the EAI problems and they maintained these skills after several weeks. However, scores on a standardized test and a
fractions computation test did not improve. Qualitatively, students reported that they enjoyed learning math using authentic tasks of planning, measuring, and building.

Role of Student Preference in Academic and Behavioral Performance

Student preference is an important variable in academic and behavioral performance, particularly with the target population. One of the major obstacles to learning for students with EBD is lack of motivation due to learning histories characterized by failure and low levels of success. In the NLTS2 study (2003) only 23% of students with EBD indicated they enjoyed school; 17% indicated that they strongly disliked school. The percentage of students who did not enjoy school was higher than in any other disability category.

Qualitative data from the Bottge, Rueda, and Skivington (2006) study found that students with negative attitudes toward school engaged in learning tasks that they found to be authentic and motivating. Teachers have a broad range of methodologies from which to choose to instruct students. However, an important consideration is knowledge of what works with individual students (Dunlap et al., 1993; Forness, Kavale, & Blum, 1997). The President’s Committee of Advisors on Science and Technology (1997) performed functional analyses of behaviors that interfered with learning in students with EBD and found that by using these functional analyses to identify preventative and instructional procedures that are geared to the characteristics of individual students, more aversive and intrusive behavioral interventions (e.g. reprimands, response-cost, time/out) can be avoided.

Perhaps, students’ own preferences for one method over another is an even greater consideration. Clarke et. al. (1995) stated that manipulating antecedent stimuli,
including instructional and curricular variables, results in a decrease in undesirable behavior during instructional activities. In this study of four elementary boys with EBD, the authors found that incorporating academic assignments related to the students’ interests reduced the disruptive behavior in all students. In addition to the reduction in problem behavior, the preferred assignments were associated with systematic increases in desirable classroom conduct and considerable increases in task productivity in three of the four boys. This study provides evidence of the strong impact that consideration of students’ preferences should have on the selection and implementation of specific methodologies for students with EBD.
CHAPTER 3

METHODOLOGY

The purpose of this study is to investigate which of three instructional delivery techniques is most effective for teaching mathematics to secondary students with emotional/behavioral disorders. Public Law 107-110, No Child Left Behind Act mandates educational practices that are supported by “scientifically-based research.” (NCLB, Section 789(37) yet there is a dearth of empirical studies on best practices for teaching students with EBD. Because of the poor educational prognosis for these students, careful attention must be paid to instructional practices. Special education, like many areas of human services, is dominated by the theoretical orientations and recommendations from those inside and outside of education. Many school practices lack a strong research base, but remain in use because they are convenient, available, or traditional (Lewis, Hudson, Richter, & Johnson, 2004).

Participants and Setting

The study sample consisted of students in grades 9 – 12 who receive special education services for emotional disturbance in an urban, public high school located in central Texas. Table 1 provides demographic information from the Texas Education Agency’s Academic Excellence Indicator System (AEIS) for the 2004-2005 school year for the campus hosting this study.
Table 1. *School Demographic Information*

<table>
<thead>
<tr>
<th>Total Enrollment:</th>
<th>1,928</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic:</td>
<td>55.5%</td>
</tr>
<tr>
<td>White:</td>
<td>34.1%</td>
</tr>
<tr>
<td>African American:</td>
<td>8.9%</td>
</tr>
<tr>
<td>Native American/Asian/Pacific Islander:</td>
<td>1.5%</td>
</tr>
<tr>
<td>Limited English Proficiency:</td>
<td>7.5%</td>
</tr>
<tr>
<td>Economically Disadvantaged:</td>
<td>48%</td>
</tr>
<tr>
<td>Special Education:</td>
<td>18%</td>
</tr>
</tbody>
</table>

Students receiving special education services whose behavioral needs necessitated intensive interventions were placed in the more restrictive setting of the self-contained classroom by an Admission, Review, and Dismissal (ARD) committee. There were three such classrooms, called the Social Behavior Skills program, on this campus. Students moved between the three teachers for their academic classes. Each of the teachers in these classrooms instructed students in the academic area in which they were “highly qualified,” as determined by the No Child Left Behind Act. This study focused only on math classes that were taught during the first, fourth, and sixth class periods.

Participants

*Students*

At the onset of this study, there were 16 participants. However, by the end of the study, data from only ten students were comprehensive enough to be usable. Data for the remaining students were incomplete due to excessive absences or long-term removal
from school for behavior infractions. The mortality threat to internal validity was not a concern, as absent students did not alter other students’ results. For students whose data files were incomplete, their information was retained and treated as a separate group, thereby enabling the researcher to model the inconsistency of attendance and variability of behavior for this population – an important byproduct of this study. Information on students who entered the classes after the study began was not included. These students participated in instruction, but were not included for data collection purposes.

Table 2 provides pertinent demographic information for all participants. In addition to gender and ethnicity, the table provides information on Age\(^1\), which denotes the age of the student when the study commenced on January 18, 2006; Age\(^2\) indicates the student’s age at the completion of data collection on May 23, 2006. When using the WRAT-3 assessment, detailed knowledge regarding the age of a student is fundamental to proper use of the instrument. Additionally, students’ actual grade level is included, as well as a measure of their grade level equivalency (GLE) in math that was recorded in the present level of functioning part of the students’ Individualized Education Program (IEP). The GLE was obtained in October of the 2005-2006 school year using the applied mathematics and calculation sections of the first version of the Woodcock-Johnson Psycho-Educational Battery. The column titled “IDEA” denotes the disability by which the student qualified for Special Education under IDEA; these labels are provided in descending order of the student’s disabilities.

Not all participants have the disability label of emotionally disturbed. However, all students were served in this self-contained setting, regardless of label, if the manifestations of their disorder adversely affected academic, personal, or social
functioning. Educational needs drive placement in special education, not disability labels.

Finally, measures of cognitive ability, such as intelligence quotient (IQ) scores, were not included in Table 2. While such scores could have provided additional information for individual student profiles, these students' IQ scores were not included because they were five or more years old. District policy dictates use of academic achievement test scores to provide more relevant data for planning instruction, so IQ is measured only when a student is first referred for special education services (C. Henderson, personal communication, June 26, 2007). Therefore, most of these students' IQ scores dated from years earlier, when the students were admitted into special education, usually during elementary school.

Table 2. *Student Demographic Information*

<table>
<thead>
<tr>
<th>First Period</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>Gender</td>
</tr>
<tr>
<td>---------------</td>
<td>--------</td>
</tr>
<tr>
<td>Clay</td>
<td>M</td>
</tr>
<tr>
<td>Crane</td>
<td>M</td>
</tr>
<tr>
<td>Drew</td>
<td>M</td>
</tr>
<tr>
<td>Lupita</td>
<td>F</td>
</tr>
<tr>
<td>Thaddeus</td>
<td>M</td>
</tr>
</tbody>
</table>


Table 2, continued.

### Fourth Period

<table>
<thead>
<tr>
<th>Student</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Age 1</th>
<th>Age 2</th>
<th>Grade</th>
<th>GLE</th>
<th>IDEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bobby</td>
<td>M</td>
<td>H</td>
<td>14</td>
<td>15</td>
<td>9</td>
<td>4.1</td>
<td>ED</td>
</tr>
<tr>
<td>Manny</td>
<td>M</td>
<td>H</td>
<td>16</td>
<td>16</td>
<td>10</td>
<td>3.8</td>
<td>ED, LD*</td>
</tr>
<tr>
<td>Mason</td>
<td>M</td>
<td>AA</td>
<td>15</td>
<td>15</td>
<td>9</td>
<td>5.2</td>
<td>ED, LD*</td>
</tr>
<tr>
<td>Thomas</td>
<td>M</td>
<td>W</td>
<td>18</td>
<td>18</td>
<td>10</td>
<td>3.7</td>
<td>ED, MR</td>
</tr>
<tr>
<td>Will</td>
<td>M</td>
<td>W</td>
<td>14</td>
<td>14</td>
<td>9</td>
<td>6.3</td>
<td>ED</td>
</tr>
</tbody>
</table>

### Sixth Period

<table>
<thead>
<tr>
<th>Student</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Age 1</th>
<th>Age 2</th>
<th>Grade</th>
<th>GLE</th>
<th>IDEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bryan</td>
<td>M</td>
<td>H</td>
<td>16</td>
<td>16</td>
<td>9</td>
<td>6.0</td>
<td>ED, LD*</td>
</tr>
<tr>
<td>Carl</td>
<td>M</td>
<td>W</td>
<td>15</td>
<td>16</td>
<td>9</td>
<td>8.1</td>
<td>ED, OHI</td>
</tr>
<tr>
<td>Chad</td>
<td>M</td>
<td>W</td>
<td>16</td>
<td>16</td>
<td>10</td>
<td>4.8</td>
<td>ED</td>
</tr>
<tr>
<td>Hank</td>
<td>M</td>
<td>H</td>
<td>14</td>
<td>14</td>
<td>9</td>
<td>5.4</td>
<td>LD*, ED</td>
</tr>
<tr>
<td>Junior</td>
<td>M</td>
<td>H</td>
<td>16</td>
<td>16</td>
<td>10</td>
<td>4.8</td>
<td>ED, LD*</td>
</tr>
<tr>
<td>Tyrene</td>
<td>M</td>
<td>AA</td>
<td>15</td>
<td>16</td>
<td>10</td>
<td>6.2</td>
<td>ED</td>
</tr>
</tbody>
</table>

*Note.* Pseudonyms have been used in place of students' real names.

Ethnicity abbreviations are: H = Hispanic. W = white. AA = African American

IDEA abbreviations are: ED = Emotional Disturbance; OHI = Other Health Impairment.

LD = Learning Disability, TBI = Traumatic Brain Injury. MR = Mental Retardation

LD* denotes students who are LD in other areas other than mathematics

### Staff

There were two staff members directly involved in the classroom activities with this study. The classroom teacher, who was also the researcher, possessed twenty years...
experience teaching students with EBD. The teaching assistant had nineteen years of experience working with various special education populations at the elementary and secondary levels. They had worked together in this particular unit for three years prior to the study. At the onset of the study, the teacher and assistant agreed that the teacher/researcher would do all math instruction and attend to all behavior management issues to preserve the consistency of the study. The teaching assistant would tend to all other classroom matters such as working with students in other subjects other than math. The assistant would also attend to all administrative and clerical duties thereby ensuring the standardization of the classroom-specific conditions of the study. Reliability checks to substantiate the integrity of the study were performed by the two special education department chairs for the campus; one having five years experience teaching students with EBD in a self-contained class; the other having four years experience teaching students with learning disabilities in a resource setting.

Setting

The self-contained classrooms for students with EBD were located in three separate portable buildings about 75 yards from the school’s main campus, but about 10 yards from each other. Each building consisted of two separate classrooms; the opposite classroom housed a general education elective classes. Classes met for fifty minutes with a six-minute passing period between classes where teachers visually observed students’ transition between portables. Most students went to lunch unescorted. Lunch was served between third and fourth periods.

Study participants received at least 80% of their academic instruction in self-contained special education classes. Texas high school students are required to earn three
credits in mathematics for graduation. Students receiving special education typically take the following progression of math classes: Integrated Math I, Integrated Math II, and Consumer Math. According to the district’s Secondary School Information Guide for 2007-2008, these locally developed math courses that serve students with disabilities are ones in which, “The students will learn to describe proportional relationships utilizing numbers, geometry, spatial reasoning, measurement, and probability. Students will apply skills in addition, subtraction, multiplication, and division to calculate decimals, fractions, integers, and use basic statistical measures to analyze data” (p. 57). Because these courses focus on similar math competencies, courses are often stacked with each other resulting in heterogeneous groupings of students. Therefore, each self-contained math class may be comprised of students representing all grade and ability levels, in any one of the three math courses.

All students receiving special education services have an Individualized Education Plan (IEP) that governs their education. The IEP dictates the settings in which special education students receive instruction, as well as any instructional modifications. Students’ IEP’s were followed during the course of this study; each IEP prescribes consistent application of behavior interventions and academic progress in mathematics.

According to Lane, Carter, Pierson, and Glaeser (2006), students with EBD often require additional supports that address behavioral deficits and excesses. All students in this study participated in a token reinforcement system that had been in place from the beginning of the school year. Classroom expectations were as follows: (a) Be on time to class and have necessary materials available; (b) participate in class and attempt
assignments; (c) respect others, yourself, and the classroom; and (d) use appropriate language, topics, and tone of voice.

The token system consisted of reinforcers for rule-following behavior, and response-cost consequences for rule violations. A bulletin board in the classroom was used to display the token system: the left side of the board was the “Stars” section, and the right side was the “Consequences” section. Each student’s name was written on a card placed on the bulletin board. Students’ name cards remained in the “Stars” section of the bulletin board as long as the student met classroom expectations. Students whose names remained in the “Stars” at the end of the day were awarded 50 to 200 points per day, depending on how many periods they were in this classroom; fifty points per period were available. However, students who had this class more than once had to remain in the “Stars” for all classes. All points were awarded, or none at all. For instance, a student who remained in the “Stars” for one class, but did not follow directions during the second class was not awarded any points. Points were entered into students’ “checkbooks” at the end of the day for use the following day. Students spent points for snacks, privileges, or saved for more expensive items, such as assignment passes.

Failure to meet classroom expectations resulted in the loss of one privilege per incident. The first instance of misbehavior caused a student’s nameplate to be moved from the “Stars” section to “No paycheck,” section of the consequences side of the bulletin board. This indicated the student would not receive a paycheck for the day. A subsequent occurrence of misbehavior resulted in the student’s nameplate being dropped to “Ineligible for Raffle.” A third incident caused a student to not be allowed to use headphones or do any activity on the computer that was not curriculum-related. Further
misbehavior caused the student to lose all computer privileges. Computer assignments were printed out and completed at the student’s desk. Continued misbehavior caused students to serve a 30-minute lunch detention. A final teacher-assigned consequence was being escorted to classes, including lunch in the classroom, for one full school day. Any subsequent rule breaking resulted in a referral to the administration.

At the end of the day, students’ name cards were moved up one level. Students who were more than three levels down could contract to move up more quickly. However, the student must initiate the contract and its terms and gain teacher consent. Additional positive reinforcement, besides social reinforcement, was provided through raffle tickets, which were given as immediate recognition of appropriate behavior. Small raffles for pencils, fruit chews, bonus points, and passes were held daily if the majority of the class was compliant. Only students above the “Ineligible for Raffle” line in the “Consequences” section of the bulletin board could win. Each Friday, a larger raffle was held where students could win homework coupons, additional hall passes, and coupons from businesses in the community.

The following procedures were components of all daily classroom operations, regardless of which instruction delivery method was in use, and occurred during the first five minutes of each class. Two minutes after the tardy bell, a 15-second music clip on the computer summoned students to their desks. This extra time allowed students with classes inside the main building to travel to the portable buildings where the self-contained classes were held. Students who were seated at the conclusion of the music clip were reinforced with either a raffle ticket or other small reinforcer. Students within sight were admitted to class but were not provided reinforcement. Students were allowed to
enter after this time. but were either marked tardy or absent, depending on the time entered. These students also were given a consequence in the token system: their name card was either moved from the “Stars” side to the first level consequence, or if their name card was already on the “Consequence” side, it was moved to the next consequence in the sequence. Consequences were reflected on the “star structure board” by dropping a privilege and noted on the behavior documentation clipboard. All classes began with the recording of attendance and other administrative-type duties including class announcements. Students who were enrolled into a class that was not part of the study were immediately dismissed to their computers to commence individual assignments. The teaching assistant was available to assist these students.

Students enrolled in one of the math classes participating in the study were verbally reminded and visually prompted with a chart regarding the targeted math objective and whether the class was using Direct Teach (DT), Computer-Assisted Instruction (CAI), or Combination (Combo) to learn that objective. (i.e., “Today we will be learning/continuing our learning about multiplication of fractions and mixed numbers. This week, our class will be using Odyssey (CAI”) ). This chart also contained the specific activities/assignments that were to be completed for the week to master the objective.

Research Design

This investigation evaluated three instructional methods to determine the most effective instructional approach for teaching mathematics to secondary students with EBD. An alternating treatments single-subject research design (ATD) was employed for this purpose. Traditional, between-group comparisons were not appropriate due to the
relatively small number of participants, as well as the intersubject variability of skill level of the student participants (Bailey & Burch, 2002; Barlow & Hersen, 1984; Skiba & Casey, 1985).

The alternating treatments design (ATD) was selected for use rather than other single-subject designs for the following reasons. First, reversal designs sequentially apply then withdraw an intervention to verify the intervention's effects on a behavior. By comparing baseline data to data collected following the withdrawal of the intervention, the effectiveness of the intervention can be established. Reversal designs and variations thereof were rejected because this study involves the acquisition of knowledge, a condition that cannot be returned to baseline. Second, multiple baseline designs apply interventions for simultaneous analysis of more than one dependent variable, including more than one individual, setting, or behavior. Once a baseline is established for a particular variable, an intervention is initiated for one individual or group, but withheld from the others. This sequence is continued until an intervention has been applied to all variables. Multiple baseline designs were inappropriate for this study because withholding instruction for any amount of time to certain groups may be ethically unacceptable in educational settings. Third, changing criterion designs utilize a gradual and systematic approach to behavior change by dividing the intervention phase into subgroups, each requiring a closer approximation of the target behavior. While this design effectively measures changeable behaviors or those that aim to change frequency, latency, or duration, they are not appropriate for academic skill acquisition.

According to Barlow and Hersen (1984), an alternating treatments design is one in which two or more treatments or conditions rapidly alternate to compare their
effectiveness. This method is ideally suited to multiple intervention comparisons when a withdrawal design is not appropriate. In an ATD, a baseline can be established, although it is not a necessary condition (Cooper, Heron, & Heward, 1987). Participants are exposed to each condition in a random manner in order to minimize multiple treatment interference, or confounding effects, which are a major threat to the validity of any experiment involving multiple treatments (Alberto & Troutman, 2006; Cooper, Heron, & Heward, 1987). Barlow and Hersen (1984) recommend at least three data probes for each condition. An alternating treatments design typically involves a post-treatment phase in which the most effective treatment is replicated. Once all treatments have been completed, data are analyzed to determine the most effective treatment.

The most common form of analysis is visual inspection to examine data paths for lack of overlap. The degree of differential effect produced by two or more different independent variables is determined by the amount of vertical difference between data paths (Cooper, Heron, & Heward, 1987). According to Bailey and Burch (2002), alternating treatments design is ideally suited to situations where several arrangements are to be compared simultaneously, as was the case with this study.

Another method of data analysis in an alternating treatment design is to calculate intervention effect size by figuring the percentage of intervention data that do not overlap with baseline data (Campbell, 2004). This is a non-regression effect size, or measure of treatment efficacy, calculated as the percent of intervention data points that do not overlap with the highest baseline data point.
Dependent and Independent Measures

The present study included a number of different dependent and independent variables. Multiple dependent variables were used to assess different aspects of the intervention. The independent variables were three different instructional methods presented in an alternating treatment design.

Dependent Variables

Three dependent measures provided a multidimensional approach to evaluating the effectiveness of the different interventions. These measures included standardized assessment of math performance, multiple curriculum-based assessments of specific math skills, and a survey of student preference regarding the three instructional methods.

WRAT-3. The first measure was the written arithmetic section of the mathematical subtest of the Wide Range Achievement Test-3 (WRAT-3). The WRAT-3 was selected because it measures the development of students’ mathematical competencies, thus allowing educators to develop an instructional program that targets specific deficiencies, and does so in a time-efficient manner. According to the WRAT-3 manual, students over the age of eight years do not take the Oral Arithmetic section. If students correctly answer at least five questions on the Written Arithmetic section, an additional 15 points, the value of the Oral Arithmetic section, is awarded. The WRAT-3 offers two forms for test-retest purposes. Initially, the blue form was administered. Results of the WRAT-3 determined the selection of instructional objectives and provided a measure of learning from a norm-referenced assessment. Broad areas of math deficits for the majority of participants became the selected targets for instruction. For example, most students showed a need for remediation in operations involving fractions. At the conclusion of the
study, the alternate form of the WRAT-3, the tan form, was administered to determine if students showed improvement over the first administration of the test.

Besides providing current levels of math functioning for individual students, the WRAT-3 described similarities and differences between and within individual participants. The scores obtained from the WRAT-3 were used with demographic information provided a comprehensive picture of math performance among participants. The two different forms of the WRAT-3 provided a standardized picture of students’ math ability before the study and at its conclusion.

*Curriculum-based assessments.* The second dependent variable was teacher-constructed, curriculum-based assessments used during the baseline, intervention, and best treatment phases, and post-instruction probe. Students completed three different versions of a teacher-constructed, curriculum-based assessment to establish baseline levels of performance. The baseline versions of the test evaluated students’ proficiency on nine selected math objectives linked to material that was taught during the nine weeks of intervention, plus one additional objective that was covered during the best treatment phase. Thus, each baseline measure consisted of twenty questions covering ten math objectives, or two questions per objective. Students were provided one 55-minute class period in which to complete the test. No calculators were permitted at any time during the study and the only assistance provided on quizzes was encouragement for students to put forth their best effort.

During the intervention phase, students completed paper-pencil quizzes linked to a specific objective at the conclusion of each unit of study. No calculators or assistance were permitted during the quiz. Students completed a summative version of the
curriculum-based measure three weeks following the conclusion of data collection to measure sustainability/maintenance related to the ten objectives. This post-instruction probe was similar to the baseline measures, as it contained twenty questions covering the ten math targets.

The purpose of the curriculum-based assessments provided a baseline and follow-up picture of students’ math knowledge on the selected objectives, as well as a summative assessment during the intervention phase. At the conclusion of presenting the objective using one of the three instructional conditions, students’ learning was assessed.

_Student preference survey._ The final dependent variable was obtained based on data obtained using a survey of student preference. Prior to beginning the study, students were solicited regarding their preference for one of the three methods by which to learn math, as well as an open-ended question about the reason for their choice. Following the completion of the post-tests, students completed a survey created on an online survey-maker to determine which instructional methods they preferred. Delivery of the survey content occurred orally and consisted of nine multiple choice and one free response question for students to offer additional information. The final survey asked students to identify which of the three methods of instruction they most preferred and which method they least preferred. A brief description about each method was included. Further, the survey asked students to describe the rationale for their choice. Possible response options were provided to facilitate completion of the item. They could select as many of those options as were applicable. The survey also asked students to identify the method in which they thought they learned the most. Finally, students were asked to identify aspects of each method that they did not like.
Obtaining information on student preference provided insight into which instructional method students preferred, which method students felt they learned the most, and the reasons for their choices. This information was used in a comparison and correlation analysis in relation to the scores students received on the curriculum-based assessments that followed each presented objective during the intervention phase.

**Independent Variables**

The independent variable in this study was the method of instructional delivery: direct teach, computer-assisted instruction, and a combination of those two methods.

*Direct teach.* Direct teach consists of instructional activities that have the explicit purpose of increasing academic achievement by emphasizing teacher behaviors and variables related to classroom structure, such as small-group instruction, teacher direction of learning, academic focus, high rates of accurate responding, controlled practice, use of higher cognitive-level questions, group responding, independent practice, and feedback to student responses (Ellis & Worthington, 1994; Heward, 1997; Jones & Southern, 2003; Scheuermann & Hall, 2008).

The following direct teach components were used during the teacher-mediated instruction conditions. The math objective being taught was written on the board daily. The teacher introduced the lesson by connecting new material to prior learning, showing a correctly finished problem, and describing how the skill could be used in real world applications. The teacher then presented the lesson in a variety of formats including lecture, modeling, and interaction with math manipulatives. Next, students practiced the skill performing problems on the board or individual dry-erase response boards; students were asked to verbally demonstrate the process or strategy for performing the work.
Next, students completed additional problems on individual dry-erase response boards while the teacher checked for understanding, and provided high levels of response opportunities. Finally, the teacher provided another example of the type of problem being studied and left that problem on the board before closing with a summarization of the lesson and its importance.

Following the direct teach portion of the lesson, students engaged in independent practice of the skill taught. The number of independent problems assigned matched the number of questions that were presented to students during computer-assisted instruction conditions for the sake of consistency. Further assistance in the form of additional explanation, or a different strategy such as a flowchart was provided as needed.

*Computer-assisted instruction.* Computer-assisted instruction (CAI) most often refers to drill-and-practice, tutorial, or simulation activities offered either independently or as supplements to traditional, teacher-directed instruction. For this particular study, the software curriculum OdysseyWare® was used. OdysseyWare® is a multimedia enhanced CAI curriculum published by Pathway Publishers® that includes diagnostic features, individualized, self-paced instruction, and teacher management utilities.

The following procedures were followed during times the class was using CAI. After beginning-of-class procedures, students were dismissed to their assigned computers. Headphones were available, but students were reminded to use them only for listening to the instruction-related material. All activities and assignments for the week were listed on a chart posted in the room. Students went to the Odyssey menu, located their name, selected “Math”, and participated in the assigned lessons. While the OdysseyWare® curriculum, offers prepared courses appropriate to a particular grade
level, the lessons assigned for this study were customized based on specific objectives to be taught. The program's scope and sequence was used to locate lessons and activities on a particular math objective at grade levels appropriate for each student. The module created for each objective was a broad sampling across grade levels and ranges of difficulty. Each module included an introductory lesson, where the skill was presented and four to six other lessons for practice. Students worked through the lessons and activities at their own pace, although a recommended schedule was provided suggesting the completion of twenty to thirty problems during a 50-minute class period.

Students were encouraged to work on OdysseyWare® independently. Those who became too frustrated were allowed to leave the computer for a brief break. Students were allowed to get tutoring from the teacher on problems similar to the ones on which they were working, but not the exact problem. Documentation of the level of assistance provided each time was included in a form of anecdotal information. Students then returned to the computer to continue working.

The teacher utilities on OdysseyWare® allowed the teacher to set the level of feedback the student received. For students participating in CAI, immediate feedback as to the accuracy of the answer was provided. Incorrect problems recycled themselves until a mastery level of 100% was achieved. Once students completed the daily assignment expectation on OdysseyWare®, they could continue working on future assignments, or access the Internet for appropriate use. If students did not finish the assigned lessons by the end of the period, a completion grade was assigned. Omitted problems were counted as incorrect, just as they would on paper-pencil tasks.
**Combined approach.** In the combination direct teach (DT) and computer-assisted instruction (CAI) condition, students received direct instruction from the teacher on the assigned material. The components of direct teach as described previously were utilized until the time for independent practice. At this point, students were dismissed to their computers where they were instructed which section of the OdysseyWare® program was to be used for the day. In this approach, students used the OdysseyWare® program as a textbook with further explanations being offered by the teacher. For example, the teacher reviewed sample problems on the board or the interactive videos on OdysseyWare® were shown to the class using the computer projector. When needed, students were assisted at their computer, just as a teacher would assist students with a problem from a textbook. The utilities of the program were adjusted such that once a student entered the answer, it was immediately assessed and missed problems did not cycle through again, as they did during the CAI condition. Grades were taken just as grades would be taken from textbook problems or worksheets.

**Instrumentation**

*OdysseyWare®*

OdysseyWare® is a multimedia enhanced, CD-Rom-based or online curriculum that offers a full range of high school courses plus electives and can be individualized to meet the unique learning needs of students. Installation of the software occurred at selected secondary, self-contained Social/Behavior Skills classrooms throughout the district as part of a Telecommunications Infrastructure Fund (TIF) Discovery grant written by the district’s assistive technology team. According to the producers of OdysseyWare®, this particular curriculum software is currently in use in 61 Texas school
districts and 108 districts nationwide (S. Vaughan, personal communication, October 3, 2005).

**Wide Range Achievement Test® Third Edition**

The Wide Range Achievement Test® Third Edition (WRAT-3) is a standardized test that is designed to be administered by teachers and provides norm-referenced age and grade level information about academic ability and problem-solving skills. The third edition of the WRAT was nationally standardized in 1992 and 1993 on approximately 5,000 individuals from a stratified, national sample. Item analysis and development of normalized scale score proceeded by using the Rasch-based item response theory (IRT) model. This model derives categorical data from the interaction between subjects and test items to obtain quantitative data on a ratio-level continuum or scale. The median reliability coefficient for the WRAT-3 was in the moderately high range of .82 to .95.

**Curriculum-Based Assessments**

The curriculum-based assessments were teacher-constructed quizzes that contained questions from OdysseyWare® and other curricular materials. During the baseline phase, these paper-pencil quizzes were a sampling of all targeted instructional objectives; there were two questions related to each objective. During the intervention and best treatment phases, all twenty questions related to the specific objective covered in class. The curriculum-based assessment used for the post-instruction probe was similar to those used during the baseline phase; there were two questions on each of the ten objectives.
Procedure

Prior to beginning of the study, the researcher obtained an acceptance number from the university's Institutional Review Board (IRB) and permission from the participating school district's Department of Program Evaluation. A parental consent form in English and Spanish was provided for students to obtain parental signatures, and a follow-up phone call was made to parents who returned the consent letter to answer any specific questions.

This study proceeded along four distinct phases. The first phase of the study served to establish a baseline, which occurred over three consecutive days. The second phase, intervention phase, provided an exposure to each instructional modality three times over a period of nine weeks. The third stage provided instruction in one additional math objective using the modality the data showed to be the most effective overall. This was called the best treatment phase. The purpose for the third phase was to demonstrate the superior effectiveness of one condition over any other. Following the baseline and intervention phases, a post-instruction probe was given to assess students' progress compared to baseline. The post-instruction probe consisted of a teacher-made curriculum-based 20-item assessment.

The WRAT-3 was administered on the first day of the baseline phase of the study. Math instruction relative to the study did not occur on the following day enabling the researcher time to use the information gleaned from the WRAT-3 to construct baseline quizzes. Class instruction on the day following the administration of the WRAT-3 consisted of detailed explanations of the study and student expectations. The baseline
phase occurred on consecutive days 3-5, when students completed one baseline quiz per day.

The intervention phase began the following week with the three math classes being randomly assigned to instructional method with all classes covering a common objective. For example, while all classes were learning to add fractions, students in the first math class were exposed to the direct teach approach. Students in the second math class were exposed to the OdysseyWare® computer-assisted instruction (CAI) to facilitate their learning to add fractions, while the students in the third math class utilized a combination of direct teach and CAI. Each respective unit of instruction was designed to be able to be covered with in a period of three to four class days. On Friday of each week, all treatment groups completed a teacher-made, criterion-referenced test relating to the specific objective covered during the week. Regardless of instructional method, all students took the same pencil-paper quiz. Students’ percentages of correct responses, on this weekly quiz (dependent variable) were graphically displayed on an individual basis. Participating students in each class produced a unique data graph, resulting in 16 single-subject studies.

The instructional condition (or treatment) for each group alternated in a random sequence for each math objective. Each objective was presented for one week using a different instructional method for each class; then a new objective and new methodology was introduced meaning that students were exposed to each instructional method three times. Table 3 shows the instructional method relative to the class period and the specific order of presentation. For example during the first week of instruction, all periods received instruction on one-digit division. First period was presented using a combination
of computer-assisted instruction and direct teach, while fourth period received instruction
only from the computer. Instruction continued in this manner for nine weeks, with each
group exposed to each methodology three times.

Table 3. Randomization of Weekly Instructional Method per Period

<table>
<thead>
<tr>
<th>Objective Number</th>
<th>Period 1</th>
<th>Period 4</th>
<th>Period 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Combo</td>
<td>CAI</td>
<td>Combo</td>
</tr>
<tr>
<td>Week 2</td>
<td>CAI</td>
<td>DT</td>
<td>CAI</td>
</tr>
<tr>
<td>Week 3</td>
<td>DT</td>
<td>Combo</td>
<td>DT</td>
</tr>
<tr>
<td>Week 4</td>
<td>CAI</td>
<td>DT</td>
<td>CAI</td>
</tr>
<tr>
<td>Week 5</td>
<td>DT</td>
<td>CAI</td>
<td>DT</td>
</tr>
<tr>
<td>Week 6</td>
<td>Combo</td>
<td>DT</td>
<td>Combo</td>
</tr>
<tr>
<td>Week 7</td>
<td>CAI</td>
<td>CAI</td>
<td>DT</td>
</tr>
<tr>
<td>Week 8</td>
<td>Combo</td>
<td>Combo</td>
<td>CAI</td>
</tr>
<tr>
<td>Week 9</td>
<td>DT</td>
<td>Combo</td>
<td>Combo</td>
</tr>
</tbody>
</table>

Note. DT = Direct teach; CAI = Computer-Assisted Instruction; Combo = Combination

The best treatment phase occurred following the ninth week of intervention. The
mode of subject presentation for the remaining math objective for all three groups was
dictated based on analysis of the collected data thereby elevating the level of
functionality and experimental control. Scores for each condition were averaged and best
treatment was determined to be the condition in which most students overall had the
highest mean score.
Data Collection

Being both researcher and teacher offered advantages and disadvantages. Researcher preference toward one method over the other is a potential source of internal validity bias. However, the researcher had extensive experience and regard for all three instructional methodologies. It was, in fact, this vacillating sentiment that gave life to this topic of study. Further, participating in one's own research study certainly increases the risk of internal validity errors. To reduce this risk, the following checks were implemented to decrease the threats to the internal validity of the study.

Two outside observers from the classroom setting performed reliability checks to assure adherence to critical components of each method and integrity of assessment. The two special education department chairs for this campus conducted these checks. Together, they offered experience in teacher appraisal and instruction with this population using the instructional methods being studied. They were provided a schedule of time during which study-related instruction would be occurring, omitting beginning of class administrative tasks and reinforcement time at the end of a class period. Each observer selected at least three, random occasions to conduct the reliability checks; these times were not made available to the researcher.

The researcher designed a checklist of the essential components of direct teach, computer-assisted instruction, and the combined approach. The observers were not informed as to the specific method in use at a particular time. If the study was being conducted adequately, the particular teaching method would be obvious. The observers were asked to note the time and date of the observation, made a determination of the methodology in use, and evaluated the components of that method accordingly. These
checklists were later pitted against information regarding which instructional method was actually in place at the time of their observation as reliability verification. As a final check of reliability, the two observers randomly inspected students’ baseline and quiz data for an expected interobserver reliability score of 100%.

Behavior management as it relates to student achievement, played a crucial role in this study because one of the research questions was to determine which instruction method was associated with higher rates of appropriate behavior. The token economy described previously was in place across all conditions.

Misbehaving students are not readily able to acquire new information regardless of the instructional method used. Misbehavior typically involves off-task behavior, or other behavior that interferes with learning. Also, misbehavior leads to consequences, which may interfere with learning. Students who exhibit serious disruptive or aggressive behavior are typically given consequences that remove them from the classroom (e.g. in-school or out-of-school suspension). Behaviors and associated consequences may result in significant losses in instructional time. Thus, low scores on quizzes could theoretically have less to do with the particular method used during instruction and more to do with variances in students’ behavior and subsequent consequences.

Data Analysis

Data analysis was conducted to determine experimental (i.e., statistical significance) and therapeutic significance (i.e., practical significance). According to Kazdin, (in Barlow & Hersen, 1984), experimental criteria, or statistical significance, has been met if the performance reliability varies to a certain degree under the separate treatment conditions. Therapeutic criteria, or practical significance depend on whether
the effects of the study make an important change in functioning. Using both statistical and practical analytic strategies, data analyses were conducted to answer these research questions: (a) which method produced the highest student performance on quizzes? (b) from which method did students feel they learned the most, and which did they prefer? and (c) which method was associated with the highest levels of appropriate student behavior and lowest levels of inappropriate behavior?

WRAT-3

Quantitative data from the WRAT-3 were analyzed to statistically evaluate similarities and differences between and within individual participants within a standardized assessment. Scores obtained from the WRAT-3 were used with demographic information to look for patterns in levels of performance among participants, as well as to assess current levels of performance.

Percentage of Non-overlapping Data

Practical effect was measured by calculating the percentage of non-overlapping data (PND) as described by Campbell (2004). PND is a non-regression statistical strategy that agrees with visual inspection of single subject data analysis and reduces bias when small numbers of observations exist, as in the case of the present study. Practical effect measures the strength of the relationship between the baseline and treatment phase; that the changes that occurred during the intervention phase did not occur by chance, but were the result of the independent variables. This was accomplished by calculating the percent of treatment (intervention) data points that did not overlap with the highest baseline data point.
Curriculum-Based Assessments

Analysis of the curriculum-based assessments followed the conventions of single-subject research designs. Quantitative analysis consisted of visual inspection of data to determine which method was most effective for conveying math objectives. Students’ individual quiz grades during baseline and intervention phases were calculated as a percentage rate of correct responses and subsequently graphed for clarity of expression. Individual participant data on the dependent variable were graphed to facilitate visual inspection regarding the lack of overlap, a strong indicator of efficacy. The greater the separation of data points, the stronger the indication of differentiation of treatment. Descriptive statistics, including means and standard deviations, were calculated for individuals, groups, and overall to determine which method was associated with the highest scores. To determine whether students exposed to a particular methodology for a particular objective received similar scores, a descriptive analysis using frequency distributions was conducted for all student-level data/scores.

Descriptive analysis using means of the data under the various conditions revealed conditions under which individual students scored highest. The mean response of each group (class) provided efficacy information on a broader level while it also served as a comparison to individual student’s data. Visual inspection of student-level trends was conducted to evaluate the level of stability of the dependent variable during exposure to a particular methodology. Further, trend analyses provided a platform to visually inspect the level of stability/consistency for the group as well as in relation to other individual students.
Preference Survey

Students' responses to the preference assessment were evaluated quantitatively and qualitatively. Qualitative analysis included evaluating open-ended responses for overall preference and particular themes. Quantitative analysis involved calculating percentages for each response for all students. Further, results of the preference survey were compared to students' actual performance on the curriculum-based assessments to determine if their preferences and perception of the more effective learning mode were congruent.

Behavior Data

Data on individual student behavior (i.e., frequency counts of behavioral events) were analyzed quantitatively by comparing the number of times students were reminded of appropriate behavior or reprimanded for inappropriate behavior with regard to which instructional condition was in place.
CHAPTER 4

RESULTS

This chapter analyzes the academic, behavioral, and preference measures that were used to investigate effective instruction methods for teaching math to students with EBD. Dependent measures to assess academic performance included pretest and post-test data for the Wide Range Achievement Test-3 (WRAT-3), as well as curriculum-based assessments used during baseline and intervention measurements, best-treatment phase, and a post-instruction probe. Behavioral data and a student preference survey were also analyzed.

Academic Measures

*Wide Range Achievement Test (WRAT-3) Scores - Pretest*

The blue form of the Wide Range Achievement Test (WRAT-3) was used as a pretest and the tan form was used as a post-test for this study. This test yields four scores: Raw Score (RS); Absolute Score (AS); Standard Score (AS); and Grade Score (GS). Each of these scores will be explained in following paragraphs as data representing each score are discussed. Each score provided somewhat different information, but all added breadth to the individual profile of each student.

Table 4 provides pretest data for all students whose data were complete enough for inclusion in the remainder of the study.
Table 4. *Pretest WRAT-3 Scores*

<table>
<thead>
<tr>
<th></th>
<th>Student</th>
<th>RS</th>
<th>AS</th>
<th>SS</th>
<th>GS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clay</td>
<td>35</td>
<td>509</td>
<td>82</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Crane</td>
<td>37</td>
<td>513</td>
<td>87</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Lupita</td>
<td>33</td>
<td>506</td>
<td>81</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Thaddeus</td>
<td>35</td>
<td>509</td>
<td>86</td>
<td>6</td>
</tr>
<tr>
<td><strong>Fourth Period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manny</td>
<td>31</td>
<td>500</td>
<td>76</td>
<td>4</td>
</tr>
<tr>
<td><strong>Sixth Period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bryan</td>
<td>28</td>
<td>495</td>
<td>69</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Chad</td>
<td>33</td>
<td>506</td>
<td>81</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Hank</td>
<td>26</td>
<td>493</td>
<td>67</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Junior</td>
<td>32</td>
<td>502</td>
<td>79</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Tyrene</td>
<td>37</td>
<td>513</td>
<td>92</td>
<td>7</td>
</tr>
</tbody>
</table>

*Note. RS = Raw Score; AS = Absolute Score; SS = Standard Score; GS = Grade Score.*
The Raw Score (RS) is the number of correct responses. While its use is limited in scope, it does allow for rough comparisons between subjects. It does not provide a precise measure of how much better one subject performed over another, but allows for a general, comparative overview.

Table 5 orders RS and AS data for participants from highest scores to lowest. These scores did reveal some notable trends. Students who got higher Raw Scores were older students and those in the upper grades. Crane and Clay were the oldest students; Crane got the most correct answers and Clay got the second most correct on this assessment. All of the eleventh grade students (there were no twelfth grade participants) scored higher than only one student. The student with the lowest RS, Hank, was also the youngest student. While Bryan was also classified as a ninth grader, it was his second year as a freshman. It is also noteworthy that Hank’s primary IDEA eligibility was LD, whereas students who scored higher were classified as ED or the learning disability was a secondary classification.

The Absolute Score (AS) uses the Rasch analysis to provide an interval scale of test items; each item is scaled according to difficulty. The scale has a mean of 500. Absolute Scores allow a more precise comparison to be made between individuals or within an individual. Students who are classified only as ED (Thaddeus, Chad, and Tyrene) averaged 509.3 on the AS scale, whereas students who met eligibility for other conditions in addition to ED (Crane, Lupita, Manny, Bryan, Hank, and Junior) had an average AS score of 501.5. Clay’s disability classification was Traumatic Brain Injury (TBI) and learning disabled; however the manifestations of his disability justified his placement in this setting. When Clay’s AS was figured in with students with comorbid
conditions. the mean for that group rose to 502.5, still less than students whose only classification is ED. It is also worth mentioning that only Crane and Lupita were diagnosed as LD in math calculation or math application, while other students with a diagnosed learning disability were diagnosed with learning disabilities in areas other than math.

Further analysis of the AS data provided additional evidence that the older students and those in upper grades scored higher. The mean AS score for eleventh grade students (Clay, Crane, Lupita, and Thaddeus) was 509.2; for tenth grade students (Manny, Chad, Junior, and Tyrene) the mean was 505.2; and the ninth graders (Bryan and Hank) had a mean of 494. Seventeen-year-old students (Clay and Crane) had a mean AS score of 511, sixteen-year-old students (Lupita, Thaddeus, Manny, Bryan, Chad, Junior, and Tyrene) had a mean of 504.4, and the fourteen-year-old student (Hank) had a score of 493.

Table 5. *WRAT-3 Pretest Raw Score and Absolute Score Data*

<table>
<thead>
<tr>
<th>RS</th>
<th>AS</th>
<th>Student</th>
<th>Age</th>
<th>Grade</th>
<th>IDEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>513</td>
<td>Crane</td>
<td>17</td>
<td>11</td>
<td>ED, OHI, LD*</td>
</tr>
<tr>
<td>37</td>
<td>513</td>
<td>Tyrene</td>
<td>15</td>
<td>10</td>
<td>ED</td>
</tr>
<tr>
<td>35</td>
<td>509</td>
<td>Clay</td>
<td>17</td>
<td>11</td>
<td>TBI, LD</td>
</tr>
<tr>
<td>35</td>
<td>509</td>
<td>Thaddeus</td>
<td>16</td>
<td>11</td>
<td>ED</td>
</tr>
<tr>
<td>33</td>
<td>506</td>
<td>Lupita</td>
<td>16</td>
<td>11</td>
<td>ED, LD</td>
</tr>
<tr>
<td>33</td>
<td>502</td>
<td>Chad</td>
<td>16</td>
<td>10</td>
<td>ED</td>
</tr>
<tr>
<td>32</td>
<td>500</td>
<td>Junior</td>
<td>16</td>
<td>10</td>
<td>ED, LD*</td>
</tr>
<tr>
<td>31</td>
<td>502</td>
<td>Manny</td>
<td>16</td>
<td>10</td>
<td>ED, LD*</td>
</tr>
</tbody>
</table>
Table 5, continued.

<table>
<thead>
<tr>
<th>Age</th>
<th>Raw Score</th>
<th>Student</th>
<th>Grade</th>
<th>Standard Score</th>
<th>Disability</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>495</td>
<td>Bryan</td>
<td>16</td>
<td>9</td>
<td>ED, LD*</td>
</tr>
<tr>
<td>26</td>
<td>493</td>
<td>Hank</td>
<td>14</td>
<td>9</td>
<td>LD*, ED</td>
</tr>
</tbody>
</table>

Note. Age is the students' age at the onset of the study, when the WRAT-3 was administered for pretest. IDEA abbreviations are: Emotional Disturbance = ED; Other Health Impairment = OHI; Specific Learning Disability = LD; Traumatic Brain Injury = TBI; Mental Retardation = MR. LD* denotes a learning disability in an area other than math calculation or math application.

The Standard Score (SS) allows for even better comparisons within and between individuals. Standard Scores are deviation scores that have been transformed from the Raw Score means and standard deviations of the age group norms. Each of the 32 age groups that were included during the norming process had a scale mean of 100 and a standard deviation of 15. By using Standard Scores, one can describe the amount of difference between scores, as it provides interval data. Further, Standard Scores can be rated using the following classifications: 130 and above = Very Superior; 120-129 = Superior; 110-119 = High Average; 90-109 = Average; 80-89 = Low Average; 70-79 = Borderline; and 69 and below = Deficient.

No students scored in the very superior, superior, or high average range on the pretest. Only Tyrene scored in the average range with a standard score of 92. Fifty percent of the participants fell in the low average range of 80-89. This included all of the first period participants: Clay, Crane, Lupita, and Thaddeus, as well as Chad from sixth period. Junior and Manny scored in the borderline range of 70-79. Bryan and Hank scored in the deficient range of 69 and below. Because age was a consideration for the conversion from raw score to standard score, Tyrene and Crane had the same raw and absolute scores yet differed significantly on the standard score because of their age.
difference of 1.25 years. Each student labeled solely ED scored in the low average or average range whereas all students with comorbid diagnoses scored in the low average range or below.

Grade scores are only minimally useful in terms of providing useful information for evaluating results. However, they do provide data that is familiar to many educators and understandable by those unfamiliar with more advanced statistical analysis. Grade scores yield ordinal data. While ordinal data have inherent natural order, there is no standard scale with equal units of measurement as there is in interval or ratio level of measurement. The ordinal information defines a mean performance of a sample of individuals from a particular grade level, thus one can determine if an individual scores higher or lower than this average performance.

By knowing the GS, one can determine if a student scores higher or lower than the average performance of students in a particular grade level that were part of the normative sample. In the present study, all students scored significantly below grade level. Tyrene’s GS was three years below his enrolled grade level, Crane was four years below grade level, Clay, Thaddeus, Chad, and Junior were five years below grade level, and Lupita, Manny, Bryan, and Hank were six years below their grade.

**Baseline Phase**

During the baseline phase, several tasks were completed. First, the WRAT-3 was administered as a pretest. These results were discussed in the previous section. Second, each student’s performance on the WRAT-3 was analyzed to identify skills to be taught. Finally, each student was given three teacher-made tests to more closely assess students' skills on the target instructional objectives.
In addition to the four types of scores described in the previous section, students' pretest results were analyzed to identify specific skill areas that would become targets for instruction. This analysis was accomplished by first ordering the objectives describing the skills assessed on the Oral and Written Arithmetic subtest. The ordering was done in terms of item difficulty and necessary prerequisite skills. For example, it is necessary to understand the concept of basic multiplication and simplifying fraction before multiplying fractions can be learned. Next, the question number(s) related to each objective was recorded next to the objectives. Finally, an analysis was made regarding those areas where the majority of students were deficient.

Based on this analysis, ten math objectives were targeted for instruction during the study. Those ten objectives were: division with a one-digit divisor, division with a two-digit divisor, simplifying fractions to lowest terms, multiplication of fractions, division of fractions, addition and subtraction without borrowing of fractions, subtraction of fractions involving regrouping, multiplication of decimals, conversion of fractions, decimals, and percents, and finding percent of numbers. Table 6 depicts the math objectives and their respective test question number.

Table 6. *Correlation of Math Objective to WRAT-3 (Blue) Question's Number*

<table>
<thead>
<tr>
<th>Math Objective</th>
<th>Question Number(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division with a one-digit divisor</td>
<td>13 14 19</td>
</tr>
<tr>
<td>Division with a two-digit divisor</td>
<td>29</td>
</tr>
<tr>
<td>Simplify fractions to lowest terms</td>
<td>18 21 26 27</td>
</tr>
<tr>
<td>Multiplication of fractions</td>
<td>24 28</td>
</tr>
<tr>
<td>Division of fractions</td>
<td>26</td>
</tr>
</tbody>
</table>
Some students demonstrated mastery in some of the identified areas by not missing any of the items related to a particular objective on the WRAT-3 pretest. However, the majority of the participants missed items involving these skills. Table 7 shows which of test items were missed by individual students as well as the percentage of students who answered each question incorrectly. Further, Table 7 provides the percentage of objectives missed by each student. An “X” next to an item’s number means the student answered the question incorrectly. Questions 21, 26, and 27 are listed in more than one objective, as they assessed accuracy of the computation of adding fractions and also simplifying the sum to lowest terms.

Questions 13 and 14, which were missed only by Hank, were easier questions related to division with one-digit divisors (e.g. basic division facts). Likewise, question 20 was simple addition of fractions with common denominators requiring no simplification in the final calculation.

Raw scores alone are not good indicators of skill mastery. Overall, Crane and Tyrene had the highest Raw Scores on the WRAT-3 with 37 questions answered correctly each. However, of the problems representing the selected ten targeted
objectives, Crane correctly answered 53% and Tyrene correctly answered 35%. Crane was able to correctly answer more advanced problems, but missed some of the more basic problems including column addition and subtraction without borrowing. These were perhaps careless errors. Further, based on Bryan's previous grade level equivalency of 6.0, his Raw Score of 28 was surprisingly low. No behavior problems were noted, and he appeared to be putting forth expected effort. In fact, all students appeared to take the test seriously and exert their best effort during this assessment.

Table 7. Analysis of Missed Questions by Individual Students

<table>
<thead>
<tr>
<th>Question Number/Objective</th>
<th>Clay</th>
<th>Crane</th>
<th>Lupita</th>
<th>Thadeus</th>
<th>Manny</th>
<th>Bryan</th>
<th>Chad</th>
<th>Hank</th>
<th>Junior</th>
<th>Tyrene</th>
<th>Item missing students</th>
<th>Percent of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Division with one-digit divisor</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>14 Division with one-digit divisor</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>19 Division with one-digit divisor</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 Division with two-digit divisor</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 Simplify fract. to lowest terms</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 Simplify fract. to lowest terms; Add/subt fractions</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>50%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7, continued.

<table>
<thead>
<tr>
<th>Question Number/Objective</th>
<th>Clay</th>
<th>Crete</th>
<th>Lupita</th>
<th>Thaddeus</th>
<th>Manny</th>
<th>Bryan</th>
<th>Chad</th>
<th>Hank</th>
<th>Junior</th>
<th>Tyrene</th>
<th>Of students missing</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 Simplify fract. to lowest terms: Divide fractions</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>27 Simplify fract. to lowest terms: Add/subt fractions</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>20 Add/subt fractions</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>32 Subt fractions with regrouping</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>24 Multiply fractions</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>28 Multiply fractions</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>25 Multiply decimals</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>30 Multiply fractions</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>23 Conversion of fract/dec/percent</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>35 Conversion of fract/dec/percent</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>34 Determine percent of numbers</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Percent of items missed</td>
<td>71</td>
<td>47</td>
<td>71</td>
<td>65</td>
<td>76</td>
<td>88</td>
<td>65</td>
<td>100</td>
<td>82</td>
<td>65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Baseline Measures

The administration of the WRAT-3 provided pretest data, which were used to identify learning objectives in ten broad areas of students' mathematical deficiencies. From these objectives, three teacher-constructed tests were developed to further ascertain students' proficiency on the ten objectives. Each test consisted of twenty questions, two questions on each of the ten objectives. The three tests were similar in that they all included the same types of problems.

Table 8 presents the results of the three teacher-made tests used as baseline measures of skills. The percentages of correct responses are presented along with the mean percentage for all tests. Students who were absent on the day of the test were given the opportunity to make up the test. However, because this study involved the acquisition of knowledge, students were allowed to retake tests only until new material was presented. Thus, baseline tests could only be made up prior to the initiation of the Intervention Phase. An N/A in Table 8 indicates tests that were not made up in the time allowed.

Compared to the types of questions students correctly answered on the WRAT-3, all students except Crane and Thaddeus performed in an expected manner on the baseline assessment. Crane missed 47% of the targeted items on the WRAT-3, but missed only 30% on the baseline measures. One inconsistency was his ability to subtract mixed numbers that involved regrouping on the baseline tests, a type of problem he was unable to correctly answer on the WRAT-3. The same inconsistency was true for conversion of fractions, decimals, and percents; he answered these types of problems correctly during the baseline phase, but answered them incorrectly on the WRAT-3. Thaddeus correctly
answered 35% of the targeted questions on the WRAT-3 pretest, he correctly answered only one question out of the sixty possible questions (1.6% accuracy) on the three baseline assessments, yet he was able to correctly solve problems involving one-digit division, fraction concepts, addition and subtraction of fractions with like denominators, and multiplication of fractions.

Table 8. Percentage of Correct Responses on Baseline Curriculum-Based Assessments

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Baseline #1</th>
<th>Baseline #2</th>
<th>Baseline #3</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>25</td>
<td>30</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>Crane</td>
<td>70</td>
<td>80</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Lupita</td>
<td>5</td>
<td>0</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Thaddeus</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Manny</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bryan</td>
<td>10</td>
<td>N/A</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Chad</td>
<td>5</td>
<td>N/A</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Hank</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Junior</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Tyrene</td>
<td>20</td>
<td>5</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

*Note. Numbers are rounded to the nearest whole number. N/A denotes student was absent for test and did not make up.*

Based on the percentages of the baseline quizzes, it is clear that most students were not proficient on the ten selected objectives. Because each of the three baseline quizzes contained two questions on each of the ten objectives, students were given six opportunities to demonstrate their skill level for each objective. Table 9 provides the
number of problems that each student answered correctly out of these six for each objective. It should be noted that there were six questions per objective. Further, it is noted that Bryan and Chad took only two of the baseline quizzes due to absences.

Table 9. *Number of Items Correctly Answered per Objective per Student across Baseline Tests*

<table>
<thead>
<tr>
<th>Math Objective</th>
<th>Clay</th>
<th>Dane</th>
<th>Lupita</th>
<th>Thaddeus</th>
<th>Manny</th>
<th>Bryan</th>
<th>Chad</th>
<th>Hank</th>
<th>Junior</th>
<th>Teri</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division with one-digit divisor</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Division with two-digit divisor</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Simplify fractions to lowest terms</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Multiplying fractions</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Division of fractions</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Addition and subtraction of fractions</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Subtraction of fractions with regroup</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Multiply decimals</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Conversion of fractions, decimals, %</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Determining percent of numbers</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Each participant's Individualized Education Plan (IEP) specified 70% as the mastery criteria for math skills. Thus, on the baseline tests, mastery of each objective would require correct answers on at least 5 of the 6 questions for any given objective. Clay displayed mastery in multiplication of decimals and in conversion of fractions, decimals, and percents. Crane demonstrated mastery in 6 of the 10 objectives: division of one and two digit divisors, addition and subtraction of fractions including those requiring regrouping, division of fractions, and conversion of fractions, decimals, and percents. Interestingly, he did not master multiplication of fractions, but did master division of fractions, a related concept. Further, he was inconsistent in his ability to accurately simplify fractions. No other students showed mastery of any of the target objectives during baseline.

*Intervention Phase*

Each week during this nine-week phase, one math objective was taught to all class periods. However, the method of instructional delivery alternated between direct teach, computer-assisted instruction, and a combination of these methods. While each class period was exposed to each method three times, the order of the type of instruction was random.

At the end of a three or four-day period of instruction, a paper-pencil quiz assessed mastery of that individual objective. Following three or four days of instruction using one of the three instructional methods, participants were given a twenty question, teacher-constructed, written quiz over the objective that had been taught that week. The number of correct responses on these untimed quizzes were converted to a percentage of
correct answers and graphed on each participant’s individual data graph (see Figure 1-10).

A visual inspection of data graphs suggests which instructional method was most effective for teaching mathematics to these secondary students with EBD. In accordance with an alternating treatments research design, the more separation that exists between data paths for each treatment, the stronger the case that one method is more effective than another. That is, greater effectiveness of a particular treatment is demonstrated when data for one treatment does not overlap, or has minimal overlap with, data for other treatments.

The variability of student behavior, low motivation, and poor attendance characteristic of students with EBD posed a threat to the internal validity of this study. This speaks to the difficulty of conducting research with this population in a public school setting. If students were absent or refused to participate, they were allowed to retake intervention phase quizzes until instruction began on the next objective. Students were encouraged to make up missing quizzes, but they often lacked the motivation to do so. This was the case with Manny, Bryan, and Crane; each missed one intervention phase quiz and did not choose to make up the quiz despite having the opportunity to do so. Clay missed three consecutive weeks of instruction and quizzes during this phase because he was expelled to a disciplinary alternative education placement (DAEP). Further, some students refused to work even though they were aware of behavioral consequences (e.g. loss of privileges) and academic consequences (e.g. lowered grades) that accompanied that choice. Tyrene had one episode of refusing to take an intervention phase quiz, while Thaddeus’ data nearly became unusable because of the number of episodes of off-task
behavior. Thaddeus participated in 67% of the intervention phase measures including all three combined probes. However, he only participated in two of the three computer-assisted instruction probes and only one out of the three direct teach probes. Figures 1 - 10 show the data graphs for each student.

The graphs are presented in order by class period. Clay, Crane, Lupita, and Thaddeus were in first period. Manny was in fourth period, and Bryan, Chad, Hank, Junior, and Tyrene were in sixth period.
Figure 1. Clay’s Data Graph

Figure 2. Crane’s Data Graph
Figure 3. *Lupita's Data Graph*

Figure 4. *Thaddeus' Data Graph*
Figure 5. Manny’s Data Graph

Figure 6. Bryan’s Data Graph
Figure 7. *Chad's Data Graph*

Figure 8. *Hank's Data Graph*
Figure 9. *Junior’s Data Graph*

Figure 10. *Tyrene’s Data Graph*
Overall, none of the participants’ data showed distinct separation between treatment conditions. Data paths for each student showed some degree of overlap across conditions. While certain patterns were evident, no one method was clearly superior to the others for all students.

**Combined Method Compared to Direct Teach and CAI**

The combined method appeared to be clearly most effective for two students. Lupita’s data showed distinct separation of the combined condition versus the other two conditions; for this student, the combined method was clearly superior to direct teach and CAI. Clay’s data, while lacking three of the nine data points, also showed separation of the combined method versus the other methods. However, Clay’s data must be interpreted with caution because he had only two scores in the direct teach condition, and only one score in the CAI condition.

There was no clear support for either direct teach or CAI, as evidenced by the absence of separation of data paths for these conditions across students.

**Combination Method Compared to Direct Teach**

There was no overlap between the combined method and direct teach for Clay, Crane, Lupita, Manny, and Hank. Thus, for 50% of the participants, the combined method generally produced higher scores than direct teach. However, Clay, Crane, and Manny only had two data points for direct teach.

**Combined Method Compared to CAI**

The combined method was superior to CAI (i.e., showed no overlapping data) for Chad, Lupita, and Tyrene. Thaddeus had only two data points for CAI; both scores were lower than his scores in the combined approach. Clay had only one data point for CAI,
but the CAI data point was significantly lower than data points for the combined approach. The combined method was more effective than CAI for 30% of the participants. While there was no overlapping data points between combined and CAI for Bryan, his data lacked one of the three combined method probes.

Direct Teach Compared to CAI

There was no overlap between direct teach and CAI for Clay, Manny, or Tyrene. Scores for direct teach exceeded CAI scores for Clay and Tyrene, while CAI was superior to direct teach for Manny. There was minimal overlap between these two conditions for Crane. However, all of these students were missing one or two data points in one or both conditions. Clay had only one data point for CAI and two points for direct teach; Tyrene had all points for direct teach but only two for CAI; Crane and Manny were missing one point for direct teach.

Overlap of all Conditions

Junior’s data showed significant overlap among all conditions, showing no differentiation among methods. Significant overlap was defined as data paths that crossed at more than one juncture. Further, the overlap on Crane’s graph among conditions is a difference in the order of scores and does not provide evidence of one method being superior to another. For example, he scored a 90% on the second CAI probe and a 95% on the third CAI probe, whereas he scored a 95% on the second combined method probe and a 90% on the third combined method probe.

Percentage of Non-overlapping Data (PND)

Practical effect was measured using a non-regression statistical strategy called Percentage of Non-overlapping Data (PND) described by Campbell (2004). The
percentage of data points which do not overlap with the highest baseline data point is calculated and measures the strength of the relationship between the baseline and treatment phase. Practical effect affirms that changes that occurred during the intervention phase did not occur by chance, but were the result of the various instructional methods.

To avoid skewing results, PND was calculated only for students who presented with all data points for all phases and probes intact. It is unknown whether a student’s missing score on an intervention quiz would exhibit evidence of non-overlap in relation to baseline score. Therefore, the percentage of non-overlapping data was calculated for Lupita, Hank, and Junior.

For Lupita and Junior, the total percentage of non-overlapping data for all three instructional conditions was 100%. No data point in the intervention phase overlapped with any baseline data point; all exceeded the highest baseline score. The PND for Hank was 89% across instructional conditions. For CAI and combined conditions, the PND was 100%. However, for direct teach, PND was 67% because he scored a 0% on the simplifying fractions quiz, which was less than his highest baseline score of 5%.

**Comorbidity of ED and LD**

Interestingly, the combined method was clearly superior only for the two students who were diagnosed with both ED and LD in math, Clay and Lupita. Not only was there distinct separation of data points in the combined methods compared to the other two, but quiz scores in the combined method were at least 10 to 20 points higher than direct teach or CAI. Students who were labeled only ED (Chad, Thaddeus, and Tyrene) lacked overlap between combined method and CAI, with the combined method being superior.
Mean Scores for Conditions

Figure 5 shows the mean for each condition for individual students. The means for Clay, Lupita, Manny, Chad, and Hank were highest for the combined method. For Crane and Bryan, the means were the same for the combined method as for another method, direct teach and CAI, respectively. The mean score for Junior was highest for CAI; for Thaddeus and Tyrene, the highest mean was for direct teach.

Mean Scores for Conditions

![Bar chart showing mean scores for each student under different conditions]

- **DT**: Direct Teach, **CAI**: Computer-Aided Instruction, **Combo**: Combined Method

- **Clay**: M = 60.0
- **Crane**: M = 51.0
- **Lupita**: M = 72.5

Figure 11. Mean Scores for Conditions
Best Treatment Phase

The Best Treatment phase is instituted in an alternating treatments design to make a stronger case for the existence of a functional relationship (Alberto & Troutman, 2006). In the present study, the tenth math objective, concepts of percents, was taught using the combined method. While the combined method was not the most effective method for all participants when looking only at lack of overlap, it was the most effective for seven of the ten participants (70%) when considering the mean scores of conditions. Because students within class periods could not logistically be taught using differing methods, the tenth objective was taught to all classes using the combined method.

Of the seven students for whom the combined method produced the highest mean during the intervention phase, four (Crane, Lupita, Manny, and Hank) scored within ten points of that mean score on the tenth objective. Crane had an average of 95 on quizzes during the combined approach; he scored 95 during the best treatment phase. Lupita had an average of 93 on quizzes during the combined approach and an 85 during the best treatment phase. Manny had an average of 42 on quizzes during the combined approach and a 50 during the best treatment phase and Hank averaged a 78 on quizzes during the combination approach and an 85 during the best treatment phase. Thus for these students, performance was consistent with previous scores for this instructional method. Table 10 includes the mean score for the conditions and the score for the tenth objective, or best treatment phase.
Table 10. *Mean Scores for Conditions and Score for Best Treatment Phase*

<table>
<thead>
<tr>
<th>Student</th>
<th>Direct Teach</th>
<th>CAI</th>
<th>Combination</th>
<th>Best Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bryan</td>
<td><strong>73</strong></td>
<td>50</td>
<td><strong>73</strong></td>
<td>40</td>
</tr>
<tr>
<td>Chad</td>
<td>58</td>
<td>58</td>
<td><strong>80</strong></td>
<td>0</td>
</tr>
<tr>
<td>Clay</td>
<td>70</td>
<td>10</td>
<td><strong>80</strong></td>
<td>0</td>
</tr>
<tr>
<td>Crane</td>
<td>90</td>
<td>95</td>
<td><strong>95</strong></td>
<td>95</td>
</tr>
<tr>
<td>Hank</td>
<td>38</td>
<td>67</td>
<td><strong>78</strong></td>
<td>85</td>
</tr>
<tr>
<td>Junior</td>
<td>47</td>
<td>58</td>
<td>53</td>
<td>75</td>
</tr>
<tr>
<td>Lupita</td>
<td>60</td>
<td>53</td>
<td><strong>93</strong></td>
<td>85</td>
</tr>
<tr>
<td>Manny</td>
<td>5</td>
<td>27</td>
<td><strong>42</strong></td>
<td>50</td>
</tr>
<tr>
<td>Thaddeus</td>
<td><strong>70</strong></td>
<td>40</td>
<td>53</td>
<td>5</td>
</tr>
<tr>
<td>Tyrene</td>
<td><strong>95</strong></td>
<td>58</td>
<td><strong>78</strong></td>
<td>70</td>
</tr>
</tbody>
</table>

*Post-Instruction Probe*

This study included two post-instruction assessments. First, a teacher-made quiz similar to the baseline measures was used as a post-instruction probe two weeks following the best treatment phase. Second, a different form (tan) of the WRAT-3 was used for a post-test that compared results to the blue form of the WRAT-3 administered at the onset of the study.

The post-instruction probe assessed math scores at the end of nine weeks of instruction. These scores were then compared to the baseline scores to determine the extent to which instruction produced gains in math skills. The format of the post-instruction probe was similar to the baseline measures. The post-instruction probe
consisted of twenty questions, two questions for each of the ten objectives that were
taught. This was similar in format to the baseline measures but contained different
problems. Table 11 provides a comparison of mean baseline scores for each student with
scores on the post-instruction probe. All scores are reported as a percentage of correct
responses.

Table 11. *Comparison of Baseline Scores to Post-Instruction Probe*

<table>
<thead>
<tr>
<th>Student</th>
<th>BL Mean</th>
<th>Post-Instruction Probe</th>
<th>Percent Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>23</td>
<td>40</td>
<td>+ 73.9%</td>
</tr>
<tr>
<td>Crane</td>
<td>70</td>
<td>80</td>
<td>+ 14.2%</td>
</tr>
<tr>
<td>Lupita</td>
<td>5</td>
<td>50</td>
<td>+ 900%</td>
</tr>
<tr>
<td>Thaddeus</td>
<td>1.7</td>
<td>20</td>
<td>+ 1076.4%</td>
</tr>
<tr>
<td>Manny</td>
<td>0</td>
<td>5</td>
<td>**</td>
</tr>
<tr>
<td>Bryan</td>
<td>7.5</td>
<td>15</td>
<td>+ 100%</td>
</tr>
<tr>
<td>Chad</td>
<td>7.5</td>
<td>40</td>
<td>+ 433.3%</td>
</tr>
<tr>
<td>Hank</td>
<td>3.3</td>
<td>15</td>
<td>+ 354.5%</td>
</tr>
<tr>
<td>Junior</td>
<td>3.3</td>
<td>25</td>
<td>+ 657.5%</td>
</tr>
<tr>
<td>Tyrene</td>
<td>8.3</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Note.** = Percent increase cannot be calculated because baseline mean was zero.
NA = Not Available due to absence

All students improved over the baseline mean. Tyrene had quit attending school
by the time the post-test was administered. When comparing the scores on the post-
instruction probe to baseline scores, Lupita made the most gain. She answered 2
questions out of 20 correctly on the third baseline test, but got 10 answers correct on the post-test. Chad scored six more correct answers than his highest baseline score of two correct answers; Junior scored four more than the baseline measure; Thaddeus and Clay got two more correct. Hank answered one question correctly on his second and third baseline test, but got three correct answers on the post-test; Bryan and Manny each improved by answering one more correctly on the post-instruction probe versus the baseline test. All scores on the post-instruction probe were superior to baseline measures except Crane, whose post-test score was the same as the second baseline test.

Wide Range Achievement Test (WRAT-3) Scores – Post Test

Data from the tan form of the WRAT-3 was obtained during the last phase of the study. The tan form of the WRAT-3 was used as a post-test for this study. As with the blue form that was used for a pretest, the post-test WRAT-3 yielded four scores: Raw Score (RS), Absolute Score (AS), Standard Score (SS), and Grade Score (GS). Table 12 provides a comparison of all four scores, pretest and post-test, for all participants.
Table 12. *Comparison of Pretest and Post-Test WRAT-3 Scores*

<table>
<thead>
<tr>
<th>Student</th>
<th>RS-Pre</th>
<th>RS-Post</th>
<th>AS-Pre</th>
<th>AS-Post</th>
<th>SS-Pre</th>
<th>SS-Post</th>
<th>GS-Pre</th>
<th>GS-Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>35</td>
<td>36</td>
<td>509</td>
<td>512</td>
<td>82</td>
<td>87</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Crane</td>
<td>37</td>
<td>48</td>
<td>512</td>
<td>535</td>
<td>87</td>
<td>117</td>
<td>7</td>
<td>PHS</td>
</tr>
<tr>
<td>Lupita</td>
<td>33</td>
<td>34</td>
<td>506</td>
<td>507</td>
<td>81</td>
<td>82</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Thaddeus</td>
<td>35</td>
<td>36</td>
<td>509</td>
<td>512</td>
<td>86</td>
<td>87</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Manny</td>
<td>31</td>
<td>28</td>
<td>500</td>
<td>496</td>
<td>76</td>
<td>66</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Bryan</td>
<td>28</td>
<td>31</td>
<td>495</td>
<td>503</td>
<td>69</td>
<td>74</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Chad</td>
<td>33</td>
<td>NA</td>
<td>506</td>
<td>NA</td>
<td>81</td>
<td>NA</td>
<td>5</td>
<td>NA</td>
</tr>
<tr>
<td>Hank</td>
<td>26</td>
<td>32</td>
<td>493</td>
<td>504</td>
<td>67</td>
<td>80</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Junior</td>
<td>32</td>
<td>34</td>
<td>502</td>
<td>507</td>
<td>79</td>
<td>82</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Tyrene</td>
<td>37</td>
<td>NA</td>
<td>513</td>
<td>NA</td>
<td>92</td>
<td>NA</td>
<td>7</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Note.* RS = Raw Score; AS = Absolute Score; SS = Standard Score; GS = Grade Score

PHS = Post High School

NA = student not present for post-test and did not make it up

Two students did not take the post-test because they were no longer in school. Chad was expelled from school for having a handgun on campus and Tyrene had stopped attending for unknown reasons. Post-test raw scores increased for all other students except Manny. Consistent with pretest performances, older students and those in the upper grades scored highest on the Raw Score (RS). Crane and Clay, the oldest students, got the most correct answers, 48 and 36 respectively. The eleventh grade students, who
were in the first period class, scored higher than most students in the lower grades, except for Junior’s Raw Score of 34 which was the same as Lupita’s RS of 34.

Manny’s RS fell three points from the pretest to the post-test, and was the lowest of all the post-test scores. On the pretest, he correctly added three or more addends and showed mastery of basic subtraction facts, neither of which he correctly answered on the post-test. Hank had the lowest pretest RS; however, his post-test RS increased to 32 (third lowest).

Recall that the mean of the Absolute Score (AS) for the WRAT-3 is 500. All students’ AS scores increased except Manny’s who dropped from 500 to 496. Students who are classified only as ED (Thaddeus, Chad, and Tyrene) all scored above the mean on the AS scale on the pretest. Thaddeus’ post-test score improved from the pretest. Neither Chad nor Tyrene were present for the post-test. Students who meet eligibility for other conditions in addition to ED (Crane, Lupita, Manny, Bryan, Hank, and Junior) had a mean of 501.5 for the pretest and 508.7 for the post-test. Clay’s score was not included in that calculation because he did not meet eligibility for ED, only TBI. When Clay’s AS was figured in with students with comorbid conditions, the mean rose to 509.1, still below the pretest mean for students labeled only ED.

Further analysis of the AS data again confirmed that the older students and those in upper grades scored higher. The mean for eleventh grade students (Clay, Crane, Lupita, and Thaddeus) rose from 509.2 to 516.5, for tenth grade students remaining in the study, Manny and Junior, the mean fell from 505.2 to 501.5. The ninth graders’ (Bryan and Hank) scores increased from a pretest mean of 494 to 503.5. Seventeen-year-old students (Clay and Crane) had a mean AS score of 511 for the pretest, the post-test score
increased to a mean of 523.5. Sixteen-year-old students (Lupita, Thaddeus, Manny, Bryan, and, Junior) had a pretest mean of 504.4 and a post-test mean of 505 (despite missing data for Chad and Tyrene). The fourteen-year-old student (Hank) had a score of 493 and increased his AS to 504.

Standard Scores increased for seven of the eight students who took the WRAT-3 post-test. The highest post-test Standard Score (SS) was Crane’s: 117 (high average), a significant increase from his pretest SS of 87 (average). Another significant increase was Hank who rose from the deficient range to the low average range with Standard Score increase from 67 on the pretest to 80 on the post-test. Bryan rose from deficient (69) on the pretest to borderline (74) on the post-test and Junior rose from borderline (79) on the pretest to low average (82) on the post-test.

Clay, Lupita, and Thaddeus experienced less dramatic increases in scores, all remaining in the low-average range on the pretest and post-test. Clay increased his pretest score of 82 to a post-test score of 87. Lupita and Thaddeus both increased by one point; Lupita rose from an 81 on the pretest to an 82 on the post-test and Thaddeus increased from an 86 on the pretest to an 87 on the post-test. Manny scored in the borderline range on the pretest (76), but fell into the deficient range (66) on the post-test. Chad and Tyrene were not in school to participate in the WRAT-3 post-test.

Post-test Grade Scores (GS) increased for all students except one; Manny’s post-test GS was unchanged from the pretest. Crane’s post-test GS increased to post-high school level, significantly higher than his assigned eleventh grade level. Clay, Lupita, Thaddeus, and Junior increased one grade level during this four-month study. Bryan and
Hank, both ninth graders, increased two years on the GS scale, but still four years below their assigned grade level.

*Interobserver Agreement*

This study was conducted by the teacher as the researcher. To minimize the risk of internal validity errors, reliability checks were conducted by independent observers to ensure reliability in the dependent measures and fidelity of implementation of the instructional conditions.

*Dependent Measures*

Reliability of dependent measures was measured by using an additional observer to rescore a random sampling of baseline tests. This observer randomly inspected 20% of the baseline quizzes and 25% of the weekly quizzes administered during the intervention and follow-up phases to make certain that papers were correctly scored and calculated. At the onset of the study, there were 16 participants. Twenty percent of 16 is 3.2 papers; thus four tests for each baseline measure were inspected for interobserver reliability. The total of 12 baseline tests had an agreement level of 100%.

Each week, the same observer scored four additional quizzes, even if not all 16 tests were taken due to absences. These quizzes were randomly chosen; the papers were not grouped according to class period. Interobserver reliability for weekly quizzes during the intervention and follow-up phases yielded an agreement level of 95%. Errors were found on two of the 40 quizzes that were inspected. Both errors consisted of a problem that was counted as correct, but which was actually incorrect.
Independent Variables

To ensure fidelity in implementation of treatment variables two outside observers randomly chose five occasions throughout the study to appraise the components of instruction being utilized. The observers were the department chairs for the special education department on this campus. They were provided dates during which no instruction would be given: the days of baseline testing and post-objective quizzes. Observers were also given a checklist of the components that should be evident during each of the three types of instruction: direct teach, computer-assisted instruction, and the combined approach. The observers were instructed to determine which of the three methods was being used for instruction during their observation by attending to activities occurring during the observation. They then used the checklist to assess whether or not each of the components was actually in use. For example, the checklist of components for the CAI condition contained items such as, “Upon entering class, students received their work folder and reported to their computer station” and “Incorrect problems recycled until students earned a 100%.” The instructional method in place during the observation was written on the board for students, but hidden from view by the observers.

Both observers simultaneously completed the five observation sessions; however each observer completed the checklist independently. After each observation, the observers compared their assessment of the instructional condition and calculated the extent of agreement between the two checklists. The rate of interobserver agreement for identification of the instructional method was 100%. The percent of agreement for critical components of each method was calculated by dividing the total number of agreements by the total number of items on the checklist. There were 17 components for the
combined method, 16 components for direct teach, and 11 components for computer-assisted instruction.

The observers attended two sessions where the combined method was in use, two sessions of direct teach, and one occasion where computer-assisted instruction was utilized. Thus, there were a total of 77 opportunities for agreement. The observers agreed on 73 of the 77 critical components, resulting in interobserver agreement of 94.8%. Agreement of 90% or higher is considered a reliable measure (Alberto & Troutman, 2006; Bailey & Burch, 2002).

Students with Incomplete Data

Several participants had so many absences that their data became unusable. While a mortality threat to the present study, they represent a more serious problem involving research with this population. Each participant's data was a single case study. Losing six participants meant losing some of the robustness of results. Many studies involving students with EBD are done in hospitals, treatment centers, or detention centers where absences are less of a problem (Mooney, Epstein, Reid, and Nelson, 2003). Yet, according to the 26th Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act (U.S. Department of Education OSEP, 2006), only 18% of students with emotional disturbance were educated outside of public school classrooms during the 2000-2001 school year.

Data from six of the sixteen original participants were omitted because of gaps in information. Drew quit attending school during the third week of the study. Thomas completed the WRAT-3 pretest, but was placed in a psychiatric hospital during the baseline phase. He remained there during the first two weeks of the study. came back for
three weeks, and then again was hospitalized for two weeks. He completed the last three weeks, but was absent for the WRAT-3 post-test. Four others, Mason, Will, Bobby, and Carl, were sent to a discipline alternative education placement (DAEP) during the study and remained there for the duration of the school year. These students, representing 25% of the original group of participants, were placed there for drug offenses occurring on campus.

Student Preference Measures

Prior to the study, students were surveyed regarding which method they preferred when learning math. The survey consisted of one multiple-choice question.

To learn math, I prefer: (a) Direct Instruction (when the teacher teaches and we do assignments at our desk); (b) Odyssey Instruction (when it’s just me and the computer); (c) Combination (when the teacher teaches and we do assignments on the computer).

Of the ten students whose data were ultimately included in the study, five (50%) reported that they preferred a combination approach where the teacher teaches the lesson and assignments were completed on the computer. Four students (40%) reported that they preferred computer-assisted instruction where students work at their own pace with work contracts and minimal teacher interaction, while one student (10%) preferred direct teach, where the teacher instructs students and the students complete assignments on paper.

At the conclusion of the study, students participated in an online survey that solicited more in-depth quantitative and qualitative information regarding their preferences for particular instructional methods. Only seven participants (70%) completed the exit survey. Bryan and Tyrene quit attending school for unknown reasons:
Chad was sent to a discipline alternative education placement for the duration of the school year for being in possession of a firearm at school.

The survey was administered by the teacher who read each question aloud. The students then selected their answers on the computer. Some questions allowed only one answer; others allowed multiple responses. The survey questions and corresponding results were as follows:

(1) Which method of instruction do you like the best?

- Direct teach (teacher teaches, students do work on paper)
- Computer-assisted instruction (Odyssey only, self-paced)
- Combined (Teacher teaches and students do work on Odyssey)

Six students (85.7%) indicated a preference for the combined approach; one student (14.2%) selected CAI. The results of the exit survey were the same as the preliminary survey for five of the seven respondents. However, Manny and Junior initially indicated a preference for CAI, but changed their selection to the combined method on the exit survey. Throughout the intervention phase, both students required higher levels of assistance during the computer-assisted instruction condition than other students. Table 13 provides the results of the preliminary survey and the exit survey addressing method preference.
Table 13. *Student Preference Survey Results*

<table>
<thead>
<tr>
<th>Student</th>
<th>Direct Teach Pre</th>
<th>Direct Teach Post</th>
<th>Computer-Assisted Instruction Pre</th>
<th>Computer-Assisted Instruction Post</th>
<th>Combination Pre</th>
<th>Combination Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Crane</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lupita</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Thaddeus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Manny</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bryan*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chad*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Junior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Tyrene*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*Note. Pre denotes the preliminary survey and Post denotes the exit survey on student preference.
* denotes student did not take post-survey due to absence.*

(2) If you selected direct teach as your favorite method, indicate the reason(s) why you prefer this method. If direct teach is not your favorite, DO NOT answer this question.

- The personal relationship between teacher and student is important to me.
- The teacher can offer different explanations and examples.
- I get instant feedback from my teacher when I answer/ask a question.
- The teacher can consider partial credit for my answers.
- The teacher can offer hands-on activities that help me learn.
- I enjoy interacting/discussing with my classmates.
Students could choose as many reasons as they wanted. As none of the students selected direct teach as their preferred method of instruction this question was not given to participants.

(3) If you selected computer-assisted instruction as your favorite method, indicate the reason why you prefer this method. If computer-assisted instruction is not your favorite, DO NOT answer this question.

- I like interacting only with my computer.
- The computer offers clearer explanations.
- I can refer back to computer examples.
- I like immediately knowing if my answer is right or wrong.
- I like being able to correct my answers immediately if they were wrong.
- The computer’s examples are colorful and interactive.
- I like working at my own pace.
- I am less distracted by my classmates.

Again, students could choose as many reasons as they wanted. Only Crane indicated a preference for computer-assisted instruction over the other instructional methods. He selected all the above reasons for his choice except, “The computer’s examples are colorful and interactive.”

(4) If you selected the combined method as your favorite method, indicate the reason why you prefer this method. If the combined method is not your favorite, DO NOT answer this question.

- I prefer both the teacher’s explanations, but also the interactive examples.
- I prefer doing work on the computer instead of paper.
• I need the teacher to give me lessons in daily increments. I enjoy the computer, but need the teacher’s help at times.

• I enjoy the computer, but need the teacher’s help at times.

• I like immediately knowing if my answer is right or wrong.

• I am less distracted by my classmates.

Students could choose as many reasons as they wanted. Six students responded to this question. Five students (83.3%) indicated, “I enjoy the computer, but need the teacher’s help at times.” Four students (66.6%) selected, “I prefer both the teacher’s explanations, but also the interactive examples.” Three respondents (50%) said, “I prefer doing work on the computer instead of paper.” Two students (33.3%) selected each of the other statements.

(5) Using which method do you think you learn the most? (This may be the same as your preferred method, but it may be different).

• Direct teach (teacher teaches, students do work on paper)

• Computer-assisted instruction (Odyssey only, self-paced)

• Combined method (Teacher teaches and students do work on Odyssey)

This question allowed only one answer. All students responded to this question; five (Clay, Lupita, Thaddeus, Manny, and Junior), or 71.4%, answered they learned more with the combined approach, one (Crane), 14.2%, indicated they learned more using computer-assisted instruction, and one (Hank) indicated that direct teach was the approach under which they learned more. These answers mirrored their preferences except for Hank who preferred the combined approach, yet felt he learned more when direct teach was used.
(6) Using which method of instruction do you like the least?

- Direct teach (teacher teaches, students do work on paper)
- Computer-assisted instruction (Odyssey only, self-paced)
- Combined method (Teacher teaches and students do work on Odyssey)

This question also allowed only one answer. Four students (57.1%) indicated they least preferred CAI. These students were Clay, Lupita, Manny; and Hank. Manny previously indicated CAI as his favored method in the preliminary survey. Three students, Crane, Thaddeus, and Junior, (42.8%) expressed that direct teach was their least preferred method.

(7) Regardless of your favorite method, indicate the drawbacks to direct teach.

(What don’t you like about it?)

- It moves too quickly or too slowly, but not at my pace.
- It is boring compared to the interactive computer.
- I don’t know my grade until the teacher grades it.
- I am distracted by other students in class.
- I have to share answering questions with other students.

Students could select as many of these answers as they wanted. When describing what they least liked about direct teach, five of the seven respondents (71.4%) expressed that it moved too quickly or too slowly. Four students (57.1%) stated that it was boring compared to the interactive nature of the computer. Two respondents (28.5%) disliked not knowing what their grade was until the teacher graded it and also indicated that they felt distracted by other students in class. One student (14.2%) indicated not liking to share answering questions with other students.
Regardless of your favorite method, indicate the drawbacks to computer-assisted instruction. (What don’t you like about it?)

- I don’t always understand the explanations that the computer offers.
- Sometimes I need help and the computer cannot answer my question.
- There is no personal relationship with the teacher.
- I don’t like having to get 100% before I can move on.
- Sometimes the computer wants too specific an answer. (I know how to do it, but don’t know the exact format being sought).

Students could select as many of these answers as they wanted. Six of the seven students (85.7%) indicated that what they least liked about CAI was that they didn’t always understand the explanations that the computer offered. Four students (57.1%) complained that the computer wants too specific an answer. Two students (28.5%) expressed that sometimes they needed help and the computer could not answer their question. One student (14.2%) agreed with the statement, “There is no personal relationship with the teacher.” No one selected the statement, “I don’t like having to get 100% before I can move on.”

Regardless of your favorite method, indicate the drawbacks to the combined method. (What don’t you like about it?)

- I just prefer to either do work on paper or go directly to the computer.
- I don’t like the computer not sending me back problems I missed.
- Sometimes the teacher teaches differently than the computer.
- I don’t like the time lag after the teacher teaches until the computer logs on.
- There is not enough room at the computer to do “scratch” work.
Students could select as many of these answers as they wanted. Two students, Thaddeus and Junior, did not select any responses to this question. Of the five students who described what they least liked about the combined approach, 3 students (60%) stated “Sometimes the teacher teaches differently than the computer.” Two students (40%) said that they did not like the fact that they did not get a second chance to correct problems they missed. Correcting missed problems until the answer was correct, called mastery learning, was a utility tool that was used in the CAI condition but not the combined approach. One student (20%) agreed with each of the following statements, “I just prefer to either do work on paper or go directly to the computer,” “I don’t like the time lag after the teacher teaches until the computer logs on,” and “There is not enough room at the computer to do ‘scratch’ work.”

(10) Please write any other comments you have regarding the three methods of teaching that you have experienced.

This was a free response question. Students were offered assistance in actual typing by allowing the student to dictate their answers, although no one requested this accommodation. Three students offered further comments; only Hank’s comment related to the study. His comment was, “It’s easy with the teacher and computer.” Junior’s additional comment thanked his teacher for the year and Clay’s comment was a positive sentiment for his teacher, as well.

Behavioral Measures

The third research question explored which instructional method was associated with higher rates of appropriate behavior. The present study was conducted over forty class periods. Each fifty-minute class period was broken into ten minutes intervals; there
were five intervals per class period. If a student engaged in inappropriate behavior during any part of a ten-minute interval, the behavior was coded into one of six categories as cited in Table 14. Therefore, if a student engaged in a particular misbehavior for the entire class period, there would be five intervals marked, one for each ten-minute interval of a fifty-minute class period.

Behavior data were kept daily on a tally sheet. The fifty-minute class period was divided into five ten-minute intervals. If a student engaged in a particular behavior, the appropriate interval was marked and the behavior categorized.

Table 14 displays behavior data for each student. Student misbehavior correlated to classroom rules and was coded in the following manner: ‘UT’ indicated an “unexcused tardy” and indicated that the student arrived after the tardy bell. For each ten minutes the student was late, an additional interval was marked under UT. Inappropriate language, loud tones, inappropriate topics of conversation, or talking at inappropriate times were indicated with ‘LG’. Failure to follow teacher’s directions was denoted with ‘FD’. Off-task behavior, engaging in task irrelevant activity or refusing to participate in instructional activities were marked with ‘OT’. Student behavior that was disrespectful to themselves, others, or the classroom was marked with ‘RP’. Examples included writing on desks, pressing keys on other students’ computers, or tripping classmates. Absences were also recorded in behavior data with ‘ABS’.
Table 14. *Behavior Data by Student and Condition*

<table>
<thead>
<tr>
<th>Student</th>
<th>UT</th>
<th>LG</th>
<th>FD</th>
<th>OT</th>
<th>RP</th>
<th>ABS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Crane</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Lupita</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Thaddeus</td>
<td></td>
<td></td>
<td></td>
<td>36</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Manny</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bryan</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Chad</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Hank</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Junior</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Tyrene</td>
<td>10</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1</td>
<td>21</td>
<td>0</td>
<td>47</td>
<td>1</td>
<td>24</td>
</tr>
</tbody>
</table>

*Note.* UT = unexcused tardy; LG = inappropriate language; FD = not following directions; OT = off-task behavior; RP = disrespect to self, others, classroom; ABS = absent.
Table 14. continued.

**Computer-Assisted Instruction**

<table>
<thead>
<tr>
<th>Student</th>
<th>UT</th>
<th>LG</th>
<th>FD</th>
<th>OT</th>
<th>RP</th>
<th>ABS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Crane</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Lupita</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Thaddeus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Manny</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Bryan</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Chad</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Hank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Tyrene</td>
<td>5</td>
<td>2</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2</td>
<td>10</td>
<td>6</td>
<td>46</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

*Note. UT = unexcused tardy; LG = inappropriate language; FD = not following directions; OT = off-task behavior; RP = disrespect to self, others, classroom; ABS = absent*
Table 14. continued.

**Combined Approach**

<table>
<thead>
<tr>
<th>Student</th>
<th>UT</th>
<th>LG</th>
<th>FD</th>
<th>OT</th>
<th>RP</th>
<th>ABS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Crane</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lupita</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Thaddeus</td>
<td></td>
<td>22</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manny</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bryan</td>
<td></td>
<td>1</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chad</td>
<td></td>
<td></td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Tyrene</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3</td>
<td>8</td>
<td>1</td>
<td>32</td>
<td>0</td>
<td><strong>28</strong></td>
</tr>
</tbody>
</table>

*Note. UT = unexcused tardy; LG = inappropriate language; FD = not following directions; OT = off-task behavior; RP = disrespect to self, others, classroom; ABS = absent*

There is not a significant difference among conditions for absences, tardiness, or respecting property. There was a minimal difference regarding following directions, a behavior that was slightly more problematic during the CAI condition. These intervals of misbehavior occurred at the beginning of class when students were dismissed to their computers. Students who did not move without further prompting were coded as FD.
There was a significant difference in regards to appropriate language for the three conditions. Students had fewer incidents of inappropriate language, tone, topics, or timing during the combination condition where there were eight language instances marked. Under the CAI condition, there were ten intervals of talking out. However, there were 21 intervals of talking out during direct teach. Lastly, students were on-task more often during the combination condition; 32 intervals of off-task behavior were recorded. However, during CAI and direct teach, there were 46 and 47 incidents of off-task behavior, respectively, representing an approximate 45% reduction in the combined instructional method.

Table 15 shows the total number of instances of unexcused tardiness (UT), inappropriate language (LG), not following directions (FD), off-task behavior (OT), and not respecting property (RP) combined followed by the number of total absences, including suspensions with respect to instructional condition. While there were four more absences during the combined condition, there were fewer incidences of misbehavior. Of the 177 total intervals marked for misbehavior, 24.8% occurred during the combined condition, while 35.5% occurred during direct teach and 39.5% occurred during CAI.

Thaddeus had a disproportional number of discipline infractions compared to other students. As can be noted in the above table, they were all for being off-task. Of the 40 days of the intervention phase, the time period in which behavior data were collected, Thaddeus was off task for at least one of the ten-minute intervals for 24 days; he was off-task for five out of the five time intervals for 14 days. Thus, on 35% of the days data were collected, he was marked off-task for all intervals. Thaddeus takes an anti-psychotic medication and has great difficulty remaining awake and concentrating. On days where
he was able to interact with the computer, for CAI or combined conditions, the number of off-task episodes decreased.

Overall, Tyrene’s behavior was greatly improved when the combined condition was in effect; only 13.3% of the intervals of misbehavior occurred during this condition. Most misbehavior, 46.6% of the intervals, was noted during CAI condition. There were zero episodes of off-task behavior during the combined condition, while there were eight intervals of off-task behavior during direct teach and 14 during CAI. Further, during CAI, Tyrene had two episodes of not following directions, a behavior that was not noted under the other conditions. He did have one fewer interval of inappropriate language during CAI than during direct teach, but that behavior existed across all conditions.
Table 15. *Individual Student Behavior Data by Condition*

<table>
<thead>
<tr>
<th>Student</th>
<th>Direct Teach</th>
<th>CAI</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Behavior – Absences</td>
<td>Behavior – Absences</td>
<td>Behavior – Absences</td>
</tr>
<tr>
<td>Clay - 1</td>
<td>1 - 7</td>
<td>1 - 11</td>
<td>3 - 5</td>
</tr>
<tr>
<td>Crane -1</td>
<td>1 - 3</td>
<td>2 - 1</td>
<td>3 - 0</td>
</tr>
<tr>
<td>Lupita -1</td>
<td>3 - 2</td>
<td>5 - 1</td>
<td>0 - 7</td>
</tr>
<tr>
<td>Thaddeus -1</td>
<td>36 - 2</td>
<td>26 - 0</td>
<td>22 - 2</td>
</tr>
<tr>
<td>Manny -4</td>
<td>2 - 0</td>
<td>0 - 1</td>
<td>2 - 0</td>
</tr>
<tr>
<td>Bryan -6</td>
<td>4 - 1</td>
<td>7 - 7</td>
<td>1 - 4</td>
</tr>
<tr>
<td>Chad -6</td>
<td>3 - 2</td>
<td>1 - 2</td>
<td>4 - 2</td>
</tr>
<tr>
<td>Hank -6</td>
<td>1 - 5</td>
<td>0 - 0</td>
<td>0 - 1</td>
</tr>
<tr>
<td>Junior -6</td>
<td>1 - 1</td>
<td>0 - 1</td>
<td>3 - 4</td>
</tr>
<tr>
<td>Tyrene -6</td>
<td>18 - 1</td>
<td>21 - 0</td>
<td>6 - 3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70 - 24</strong></td>
<td><strong>63 - 24</strong></td>
<td><strong>44 - 28</strong></td>
</tr>
</tbody>
</table>

*Qualitative Description of Students' Results*

This section integrates students’ results and qualitatively examines data in terms of how variables beyond the study’s independent variables affect student performance on the dependent variables (WRAT-3, curriculum-based assessments, preference survey, and behavior data). One or more extraneous factors had mitigating effects on results for several students. These factors included students’ home life experiences, students’ classroom behaviors, disciplinary actions administered to students, students’ overall level
of motivation, and learning patterns characteristic of students’ disability conditions. These factors reflect the literature explaining poor academic performance of students with EBD and the difficulty of providing effective academic interventions for this population.

Careful examination of students’ behavioral records, attendance records, anecdotal notes and data from the preference survey revealed that one or more of these factors may have affected quiz scores and/or WRAT-3 post-test scores for several of the subjects. In this section, factors that affected students’ performance on dependent variables will be described.

Clay. Clay was one of the oldest students (age 17) in the study and the only one without primary or secondary eligibility of ED. Clay met IDEA eligibility for TBI and LD in math calculation. His Grade Score on the pretest form of the WRAT-3 was 6, which was consistent with his current IEP grade level functioning of 6.0 in mathematics. According to his baseline assessments, Clay demonstrated mastery (at least five out of six correct responses) in two of the ten targeted objectives: multiplication of decimals and the conversion of fractions, decimals, and percents. Thus, regardless of the instructional method being utilized to teach those concepts, it would be expected that his curriculum assessment would be fairly high. Indeed, he scored 80% on the multiplication of decimals quiz and 70% on conversion of fractions, decimals, and percents.

On the first day of the Intervention Phase, Clay was suspended from school for two days for being in possession of drugs at school. He returned to school and completed the first curriculum quiz. His manifestation hearing was at the beginning of the second week, and he was sent to the disciplinary alternative education placement and stayed for
three weeks. He missed a total of three weekly quizzes: two during the CAI conditions and one during a DT condition. Even after his return to school, Clay was absent at least once a week through the end of the study. Attendance may partially explain his low score of 10% on the quiz on 4/14; he missed two of the four days of instruction that week. However, he missed two of the four instructional days the previous week, as well, and scored an 80% on that weekly quiz. However, during the week of 4/7, Lupita was absent on the days Clay was present. Thaddeus refused to participate at all during that week; thus Clay only had to share teacher attention with one other student, which likely had a positive effect. Clay was absent twice during the week of the best treatment phase, including the day of the assessment. When he made up the quiz, he scored 0% stating he knew nothing on it.

Clay showed progress in mathematics over the course of the study. While not dramatic, his WRAT-3 Absolute Score rose from 509 on the pretest to 512 on the post-test, and from a Grade Score (GS) of 6 on the pretest to GS of 7 on the post-test. Further, the mean score for his baseline measures was 23.3%, whereas his score on the post-instruction probe was 40%, a 71.6% increase.

Clay indicated a preference for the combined method of instruction. The results of his quizzes indicate that the combined method was, in fact, the most effective method for learning math. These results, however, must be viewed with caution because of the number of missing data points. Only two probes were available for direct teach and one probe was available for CAI. Overall, it appears that Clay benefited from math instruction and increased teacher attention, but that his performance might have been
affected by factors such as attendance, impulsive behaviors engaged in without regard for consequences, behaviors characteristic of his brain injury.

Crane. Crane was the oldest student (age 17) in the study. His Grade Score on the pretest form of the WRAT-3 was well below the 11.8 grade level functioning stated in his IEP. While no inappropriate behavior or other noted circumstance accounted for this inconsistency in performance, his post-test GS score on the WRAT-3 was Post High School, more consistent with the grade level equivalency of his IEP. On baseline assessments, Crane demonstrated mastery criteria of at least five out of six correct responses in six of the ten targeted objectives: division with one and two digit divisors, addition and subtraction of fractions, including those involving regrouping, division of fractions, and conversion of fractions, decimals, and percents. While he correctly answered five out of six questions on the baseline involving division of fractions, he was only able to correctly answer one out of six questions involving multiplication of fractions, seemingly a prerequisite skill for division of fractions.

Crane put forth his best effort and completed all assignments even though he had shown mastery in many of the areas. However, during the final week, Crane was absent on the first day of instruction and suspended from school on the last day of instruction for that objective and for the weekly assessment. He refused to make up the quiz, thus he has only two quiz scores for direct teach.

Crane demonstrated academic progress over the course of the study. The Standard Score (SS) on the WRAT-3 pretest placed him in the low average range with a score of 87; his post-test SS placed him in the high average range with a score of 117. Crane had a mean score of 70% for his baseline assessments; however his post-instruction probe score
of 80% was the same as one of his baseline scores. Given that Crane’s behavior was, for
the most part, acceptable, and that he seemed to try hard and participate in instructional
activities most of the time, it appears that the primary explanation for Cranes’
inconsistent performance is his learning disability: such inconsistency is a cardinal
characteristic of this disability.

Crane indicated a preference for the CAI method. The results of his data support
his preference. CAI and the combined approach were more effective than direct teach for
learning math, although one data point was missing for direct teach. However, there was
some overlap between CAI and the combined method indicating that either the CAI or
combined method is more effective than direct teach for Crane.

**Lupita.** Lupita, the only female participant, was one of two students who met
eligibility as a student with a learning disability in math calculation in addition to
eligibility as ED. Her WRAT-3 pretest Grade Score of 5 was similar to the current
functioning level of 6.0 stated in her IEP. She did not achieve mastery on any of the ten
targeted objectives during baseline assessments and her baseline mean score was only
5%. Lupita also demonstrated the characteristically inconsistent performance of a student
with learning disabilities. For example, she was absent for all days of instruction during
the first week of the Intervention Phase, yet she scored 95% on the assessment for that
objective.

The combined method was clearly more effective than direct teach or CAI for
Lupita, although she had seven absences during the periods that the combined method
was in effect. This was also her preferred method, and the method by which she believed
she learned best. Behaviorally, she had five episodes of misbehavior during the CAI
condition and three episodes during direct teach compared to zero episodes of misbehavior during the combined approach. This interesting finding may suggest that Lupita's behavior is strongly influenced by instructional conditions: when instruction is clear and effective for her, her behavior is better. This is consistent with research demonstrating the positive correlation between effective instruction and appropriate behavior.

**Thaddeus.** Thaddeus was one of three students who met eligibility criteria for only ED. His IEP indicated a grade level functioning in mathematics of 5.5. His WRAT-3 pretest Grade Score of 6 was consistent with this assessment. Thaddeus expressed a strong dislike for the subject of mathematics and answered only one question correctly on all three baseline measures. However, he did seem to exert good effort during instruction on the first two objectives – first using the combined approach, and second using CAI. During the third week of the intervention phase, (the direct teach method) Thaddeus refused all instruction and class work, including quizzes. He entered class and immediately put his head down on his desk. This behavior continued daily except for one day during the week of the fourth objective and one day during the week of the sixth objective. He refused any intervention or explanation.

The fact that Thaddeus’ data set is lacking scores for two direct teach probes and one CAI probe makes it impossible to draw any conclusions about the more effective instructional method. Clearly, his behavior had a major impact on his academic performance. There were 36 five-minute intervals of off-task behavior during direct teach, as opposed to 26 intervals during CAI and 22 intervals during the combined approach. On the preference survey, Thaddeus indicated that he least preferred the direct
teach method and that he preferred the combined approach. His higher levels of off-task behavior during direct teach seem to support his preferences.

Despite the instructional time Thaddeus spent off-task, he raised his WRAT-3 pretest Raw Score of 35 to a post-test score of 36. This one point increase advanced his Grade Score from 6 to 7. Further, his baseline mean score of 1.7% increased to 20% on the post-instruction probe.

Thaddeus’ behavior is characteristic of students with emotional disturbance. Often, it seems that these students behave in ways that deliberately sabotage their success. This was the case with Thaddeus. He clearly had the capacity to learn math, as demonstrated by his scores on the first two weeks’ quizzes. Yet, when asked to learn math using a method that was not pleasing to him, he discontinued his efforts.

Additionally, while it is not known if a medication change occurred at any point in the study, it is possible that Thaddeus’ anti-psychotic medications interfered with his ability to concentrate early in the morning, which was when his math class met.

Manny. Manny was the only student in fourth period whose data was complete. All other students were expelled for behavioral infractions and new students were added to the class after the study began. Manny’s WRAT-3 pretest Grade Score of 4 was consistent with the grade level equivalency of 3.8 reported in his IEP. His Standard Score of 76 on the pretest placed him in the borderline range. He did not correctly answer any questions on any of the baseline assessments. Manny’s attendance during the study was very good. He missed only one day; however, he missed a curriculum assessment for the sixth objective and refused to make up the test before instruction on the next objective commenced.
Manny lacked confidence in his math skills and required close supervision to put forth effort. Often, he did not require assistance; he just required the teacher to sit close to him and encourage him to keep working. His scores during the intervention phase reflected his difficulty with the subject. None of his scores were in the passing range. There was overlap of data points between CAI and the combined approach, but none between the combined approach and direct teach, indicating efficacy for the combined method. Those results should be viewed with caution, however, because only two of the three data points for direct teach were present.

Manny’s score on the WRAT-3 fell from a Raw Score of 31 on the pretest to 28 on the post-test. His Standard Score also dropped into the deficient range, yet the Grade Score remained the same. He scored 5% on the post-instruction probe by getting one answer correct out of the twenty questions.

Manny had initially stated that it was easier for him to learn using CAI than the other two methods. However, on the survey taken at the conclusion of the study, he indicated that he preferred the combined method and also thought that he learned more under the combined conditions. In fact, he identified CAI as the method he liked least. This was perhaps due to his recognition that he benefited from the close monitoring and prompting by the teacher to make the small amount of progress that he demonstrated during the combined method. This may indicate that Manny would benefit from intensive individual math tutoring and/or an intervention that reinforced progressively more independent performance. Manny displayed appropriate behavior most of the time. He exhibited off-task behavior during two intervals under the combined condition and one
incident of off-task behavior and one incident of disrespect under the direct teach
condition. None of these negatively impacted the results of Manny's data.

**Bryan.** Bryan was a 16-year-old ninth grader who displayed oppositional behavior
and had twelve absences including three days of suspension. His poor attendance and
emotional variability negatively impacted his math performance. Bryan's pretest Grade
Score on the WRAT-3 was 3, three grade levels below his math functioning level
reported in his IEP. Bryan seemed insecure about his math abilities and was very anxious
about working independently, a condition under which quizzes were taken. For example,
when given his quiz, Bryan typically would ask multiple questions asking the teacher to
verify if his answer was correct. He also repeatedly stated that he didn't know any of the
material, although it is clear by his scores that he had retained at least some amount of
information. Further, when unsure about how to proceed with a problem, he would get
very angry and often refuse to complete the quiz.

Only four of his quizzes during the intervention phase were above the 70%
passing standard, which casts suspicion about his IEP functioning grade level of 6.0
because none of the targeted objectives were beyond the Texas Essential Knowledge and
Skills, a sequenced curriculum guide, for the sixth grade. Further, during weeks four and
eight of the intervention phase, Bryan was absent three of the four days of instruction. He
scored only 25% on the quizzes over the math objectives taught during these weeks.
Additionally, during week four, he had several episodes of classroom misbehavior
including inappropriate language, failure to follow directions, and being off-task. Thus, a
strong case can be made for the fact that Bryan's behavior and attendance negatively
influenced his performance.
Bryan’s post-test WRAT-3 Grade Score was 5 and his Standard Score rose from 69 in the deficient range on the pretest to 74 in the borderline range on the post-test. His post-instruction quiz score was 15%, demonstrating a small gain over his mean baseline measure of 7.5%. It should be noted however, that he took only two of the three baseline assessments due to an absence and failure to make up the missing task. Bryan’s emotional variability of depression, anxiety, anger, and opposition contributed greatly to the inconsistency of his academic performance. For this reason, caution must be taken when performing data analysis only by visual inspection of the data graph.

*Chad.* Chad was one of three students with a sole diagnosis of ED. However, his pretest Grade Score of 5 placed him five grade levels below his enrolled grade. This Grade Score was consistent with the functioning level of 4.8 stated in his IEP.

Chad’s classroom behavior was passive and compliant for the most part. Concerns about suspected drug use were discussed with his parent who shared these concerns. Chad seemed more capable than effort often exhibited in class. For example, he could mentally compute several steps in a multi-step problem. Further, the quality and quantity of his work varied greatly. Some days he would produce an acceptable amount of class work; other days he would verbally express his unwillingness to fully participate or provide indiscriminate responses to questions he likely knew.

Attendance also appeared to be a factor that affected Chad’s learning during the course of the study. He missed one baseline assessment due to an absence. Beginning in the fourth week of the intervention phase, he missed one day of school per week, except for the sixth week. He missed two days during the ninth week and two days during the best treatment phase, where he scored 0% on the curriculum assessment for that week.
On the assessment during the best treatment phase, he wrote down two random answers that did not seem related to the problem at all. For example, when asked, “Eight is what percent of twenty?” his answer was 2.5, yet no ratios were set up that would have helped him arrive at an answer.

The combined method appeared to be more effective for learning math for Chad. There was minimal overlap between the combined method and direct teach, and no overlap between the combined method and CAI. There was considerable overlap between direct teach and CAI. His post-instruction probe showed an improvement of 40% over his baseline mean score of 7.5%. Only two of the three baseline measures were completed.

Chad was expelled before his WRAT-3 post-test or final preference survey could be completed. In the preliminary survey, he indicated that he preferred CAI.

Chad’s performance is consistent with overall behavior and academic performance of students labeled ED. His low levels of motivation, sporadic attendance, and behavioral infractions all combined to interfere with his ability to learn. Chad’s academic progress and school behavior fluctuated greatly during periods when his mother was out of town. Personal business took her away from home about twice a month. While a family friend would stay with Chad at his home, it was obvious that his mother’s presence offered the stability Chad needed to be successful at school.

Hank. Hank was the youngest participant in the study at age 14. He was also the only participant who had a primary, as opposed to secondary, label of Learning Disabled, albeit in an area other than mathematics. His WRAT-3 pretest Grade Score of 3 was well below the level of math functioning of 5.4 reported in his IEP.
Attendance seemed to contribute to one of Hank's low quiz scores. During the third week of the intervention phase, Hank was absent four out of the five days of that objective, including the day of the curriculum-based assessment. He attempted to make up the quiz, but did not get any correct. Other than that week, Hank's behavior was cooperative and compliant.

Hank made slight progress in mathematics over the course of this study. The Standard Score on the pretest form of the WRAT-3 was 67 in the deficient range, yet the Standard Score for the post-test was an 80 in the low average range. The mean baseline score was 3.3% and his post-instruction probe increased to 15%.

Initially, Hank indicated a preference for the combined method because he liked the diversity of teacher-mediated instruction combined with the interactive aspect that the computer offered him. However, on the final preference survey, he indicated that while he still preferred the combined method, he felt he learned more using direct teach. His identification of direct teach as the most effective method was not supported by his performance on quizzes, however.

Junior. Junior's pretest WRAT-3 Grade Score of 5 was consistent with the grade level identified in his IEP of 4.8. While he did have six absences during the Intervention Phase, his behavior was mostly cooperative. This represented a significant behavioral change, as Junior had a history of aggressive, argumentative, non-compliant behaviors during class. He seemed to enjoy the fact that he was contributing to his teacher's college work and that his grade would be determined only on effort rather than traditional results-based. This is an interesting finding, speaking to the importance of motivation for these students: sources of effective motivation are not always immediately apparent or easily
identifiable. Had this study not been implemented, we may never have identified such an unusual source of motivation for Junior.

There was significant overlap in Junior’s data, thus it is impossible to determine the most effective method of instruction. His highest score as well as the lowest score during the intervention phase was achieved during the direct teach approach. However, the second highest score was the post-instruction probe using the combined method. Neither the highest score nor the lowest score was associated with behavior problems or absences.

Junior made progress in math performance during the course of the study, even though it cannot be attributed to a particular method of instruction. The Standard Score on the WRAT-3 was 79, which was in the borderline range; his post-test score was 82 in the low average range. Further, his Grade Score increased from 5 on the pretest to 6 on the post-test. His mean baseline score was 3.3%, whereas he scored 25% on the post-instruction probe.

Initially, Junior chose direct teach as the method he most preferred. However, at the study’s conclusion, he selected the combined method as his favorite and direct teach as the method he least preferred.

*Tyrene.* Tyrene’s Grade Score on the pretest form of the WRAT-3 was 7, which was consistent with his current IEP grade level functioning of 6.2 in mathematics. He did not demonstrate mastery in any of the targeted objectives.

During the first seven weeks of the intervention phase, Tyrene received all passing scores with the exception of the second week where he slept through the quiz and refused to redo it at a later time. The score for the quiz during week four was very good.
considering he was marked off-task for sleeping during the entire class period for two
days. However, his scores plummeted by week eight and nine. During week eight, he was
marked only for one episode of not following directions, thus externalizing behaviors
were not present. His low score for the objective for week nine could be attributed to his
missing class three days. During the best treatment phase, Tyrene's behavior deteriorated
significantly. He was absent one day, at least ten minutes late to class on all the other
days, and slept through class each day except one.

Behaviorally, Tyrene had more intervals of talking out or using inappropriate
language (ten) during the time direct teach was in effect. He had six such episodes during
instruction with the combined method and five during CAI. During CAI he had two
instances of failing to follow directions, whereas this behavior was not noted for the other
conditions. More significantly, he had 14 episodes of being off-task during CAI
compared to none during the combined approach and eight during direct teach.

Tyrene was missing one data point for CAI, thus a statement of efficacy must be
made with caution. While there was overlap between the combined approach and direct
teach, there was no overlap between those methods and CAI. His scores were higher for
direct teach, yet his behavior may have contributed to the low score on the ninth
objective. He quit attending school after the best treatment phase, so there are no scores
by which to compare his baseline assessments or WRAT-3 pretest. While his preliminary
survey indicated a preference for direct teach; he did not complete the final survey.
CHAPTER 5

DISCUSSION

The purpose of this study was to determine the most effective instructional method for teaching mathematics to secondary students with EBD in a self-contained special education setting. A single-subject research design employing alternating treatments was used to determine efficacy of three methods of instruction. The small number of participants available for the study precluded a group research design. For this reason, a single-subject research design was most appropriate. An alternating treatments design provided the highest level of experimental control, given the restraints and limitations of this type of research in a school setting.

The dependent variables used to determine the effectiveness of interventions were standardized scores yielded from the Wide Range Achievement Test -3 (WRAT-3), multiple curriculum-based assessments of specific math objectives, and a survey of student preference regarding the instructional methods. Three types of instructional methods were compared for effectiveness: direct teach, computer-assisted instruction, and a combination of those methods.
Data Summary and Discussion

This study affirms the complexity of conducting research with students with EBD. This is evident in both the loss of participants over the course of the study and by the missing data from students who did remain in school for the duration of the study. The study commenced on January 17, 2006 and ended on May 23, 2006. During that single semester, six of the original sixteen students who intended to be part of the study stopped attending school, were placed in alternative placements, or were absent to a point where their data were insufficient for conclusions to be drawn. This represented a 37.5% reduction in study participants over the course of this study. Further, of the ten students whose data were usable, six of them were absent for illness or truant at least once and did not make up the elements within the dependent measures, though all were given the opportunity to do so prior to the introduction of a new objective. This attrition due to absence is typical of students with EBD according to studies of attendance patterns for this population (Facts from National Longitudinal Transition Study - 2, 2006; Lane, Carter, Pierson, & Glaeser, 2006). The apathy, non-compliance, and failure to complete assignments, even when faced with grade reduction, is also consistent with behavioral characteristics of students with EBD, as described by Kauffman (2005) and Algozzine, Serna, and Patton (2001).

Seven of the original sixteen participants in the current study had dual labels of Emotionally Disturbed and Learning Disabled. Such comorbidity is common – as high as 53.2% of the ED population according to Mattison, Hooper, and Glassberg (2002). In the present study, 43.7% of participants had both of these labels. However, not all of these students had learning disabilities in math computation or math application. As can be
seen in Table 2, of the original sixteen participants, five students (31.2%) were labeled only ED, while the other eleven (68.7%) were identified with at least one other disabling condition including Other Health Impaired, Traumatic Brain Injury, and Mental Retardation. These comorbid conditions contribute to the behavioral and academic complexity of emotional disturbance and complicate instructional decisions. Specific strategies may be appropriate for one population of learners, but inappropriate for others. For example, students with learning disabilities often benefit from additional time for responses to questions. However, for students with ED, a quicker pace with more opportunities to respond is often recommended to keep students focused and engaged.

The level of mathematics achievement of these students was consistent with literature reports of math performance of students with EBD. Bottge, Rueda, and Skivington (2006) found that 56% of students with EBD are at least three grade levels behind their grade placement in mathematics. All ten students (100%) in the current study were at least three grade levels behind their grade placement in math, as evidenced by the Grade Score (GS) on the WRAT-3 illustrated in Table 4. Further, according to Nelson, Benner, Lane, and Smith (2004) the math deficiencies are more resistant to change than reading and written expression. The quizzes that were presented during the intervention and best treatment phases were curriculum-based assessments. That is, the material was taught using one of the three instructional methods and tested at the end of that school week. Of the 100 quizzes that were administered during these phases, 41 were below a passing standard of 70%, and ten quizzes were refused or never made up from students who were absent.
The relationship between academic performance and students with EBD described by Trout, Nordness, Pierce, and Epstein (2003) was evidenced in this study. Regardless of whether behavior problems have caused academic problems or whether academic deficiencies have perpetuated behavior problems, there is a definite relationship between these two factors. All students but one who participated for the duration of the study showed an increase in their Raw Score of the WRAT-3 from pretest to post-test. Yet, with the exception of Crane, all remained at least four grades below grade level on the Grade Score. Thus, some of the targeted math objectives may have been very difficult for students to conceptualize, especially given the time constraint. Difficulties in learning could create an aversive environment that students would want to escape. Nine of the ten participants were absent for at least four of the forty days of the study; three of them were absent in excess of the number of days allowed to receive credit for a course. Being absent from instruction causes students to fall even further behind academically. Additionally, 21 of the 76 absences that occurred during the course of this study were the result of suspensions. The cyclical relationship between attendance and low academic performance could account for these students’ below grade level placement.

To compensate for students with poor attendance patterns, self-paced instruction such as OdysseyWare® offers an alternative to teacher-mediated instruction where pacing of instruction is set to accommodate needs of many students. However, these students often lack self-regulation skills and, perhaps because of comorbidity with other disabilities, experience difficulty in self-instruction. Thus, while these students could seemingly benefit from instruction that they can access when they are physically and emotionally prepared, they often struggle with independent learning.
Research Question One

The first research question sought to determine which instructional method was most effective for teaching mathematics to secondary students with emotional and behavioral disorders—direct teach, computer-assisted instruction, or a combination of these two approaches.

In an alternating treatments research design, the effectiveness of a particular intervention is demonstrated when there is separation between data paths representing data for each intervention (i.e., instructional condition). A data path is simply all the consecutive data points for each condition connected by a solid line. The greater the distance between data paths for each treatment, the stronger the case that one method is more effective than another. In this study, no single instructional method clearly was superior for every student. However, careful examination of each student’s data, as well as consideration of other data sources, revealed a number of interesting results.

First, the combined method appeared to be the most effective instructional method for Lupita and Clay, given the distinct separation of data paths between the combined method and the other methods. Clay’s data, however, must be cautiously interpreted because of the number of missing data points. Both of these students are also the only participants identified as having a learning disability in math computation or application. For Chad, Hank, and Crane, the combined method appeared to be slightly more effective, as evidenced by separation of all but one data point for this condition for each student.

For Manny, Bryan, and Junior, and Tyrene, the data paths overlap significantly, thus the most effective method cannot be determined. For these students, the instructional method used was not as vital as other factors including preference, motivation, and
emotional status. For Thaddeus, there are too few data points to make a definitive statement of effectiveness; the combined method was the only method with three data points.

Most students did make gains in mathematics over the course of the study as evidenced by the scores on the WRAT-3 pretest and post-test. For most students, the pretest Grade Score on the WRAT-3 was consistent (within one year) of the previously established grade level found in students’ IEP. Only three students (Crane, Bryan, and Hank) had WRAT-3 pretest scores that differed by more than one year. Crane’s pretest score was 4.8 years lower than his IEP grade level, Bryan’s score was three years lower, and Hank’s was 2.4 years below the IEP grade level. Crane’s discrepancy was likely caused by hurrying through the WRAT-3 assessment because he was overconfident in his abilities. Bryan’s uncooperative attitude at times possibly accounts for his reduced score, although no externalized behaviors were noted. The discrepancy in Hank’s score is more likely caused by the inconsistency of academic performance that characterizes students with learning disabilities.

While two students did not take the WRAT-3 post-test, those who did, with the exception of Manny, made at least one year’s progress during the four-month study. Manny’s Raw Score dropped 9.6% and his Grade Score stayed constant. Again, it is likely the inconsistent performance characteristic of a learning disability likely accounts for the score reduction. Regarding students who did make gains from pretest to post-test, it is obvious that carefully designed and monitored lessons do result in the improvement of learning outcomes. Lessons presented during the course of the study were selected based on data collected and analyzed for patterns of deficiency across students.
Instruction was planned in advance for the whole semester. Comprehensive lesson planning and delivery of instruction based on adherence to critical components of a particular methodology provided positive results.

Overall, with respect to the first research question, the combined method appears to be most effective for the majority of students regardless of disability and specifically for students who have a learning disability in mathematics. While there were mitigating circumstances including attendance, behavioral, and emotional issues that perhaps explained certain scores, the combined method was found to be most effective for half of the participants.

Research Question Two

The second research question sought to determine which of the three instructional methods was most preferred by participants. Motivation and preference are important consideration for students who are reluctant learners, such as many students with EBD (Bottge, Rueda, & Skivington, 2006; Dunlap et al., 1993, Scheuermann & Hall, 2008).

Prior to the start of the study, half of the students (Bryan, Chad, Crane, Junior, and Manny) indicated that they preferred the CAI method of instruction; 40% (Clay, Hank, Lupita, and Thaddeus) indicated a preference for the combined approach and only one student (Tyrene) preferred the direct teach method. Seventy percent of the student participants completed the final preference survey. Of these students, 85.7% (Clay, Hank, Junior, Lupita, Manny, and Thaddeus) indicated a preference for the combined method, while only one student (Crane) indicated a preference for CAI. No student indicated a preference for direct teach, although Tyrene, who initially indicated a preference for direct teach, was not present for the latter survey.
On the preference survey, Crane maintained his preference for CAI, as well as indicating that this method was the one from which he learned the most. However, the average of his quiz scores for CAI and the combined method were the same. Furthermore, there was only minimal overlap (only one data point) for the two methods. On the survey, Clay, Hank, Lupita, and Thaddeus indicated their preference for the combined method. All but Hank, who indicated he learned best using direct teach, stated that the combined method was also the method from which they felt they learned the most. The average for the quizzes under the combined approach was indeed higher for Clay, Hank, and Lupita. However, Thaddeus’ average for the combined method was a 53, whereas his score during the direct teach approach was a 70. However, Thaddeus had only one data point for the direct teach method.

Junior and Manny changed their preference over the course of the study from CAI to a combined method. While Manny’s quiz averages during the combined approach were higher than in other methods, Junior’s average was higher for CAI than for the combined method. It should be noted, however, that while averages of quiz scores indicated superiority of one approach over another, these students’ data paths overlapped such that effectiveness of one method over another could not be determined.

In summary, five of the seven students (71.4%) received a higher mean score in the area of their preference as stated on the post-treatment survey. Two students (28.5%) received a higher mean score in an instructional approach other than the one identified as their preference. Thus, preference may be important to motivate students to attempt tasks, but may not be the best indicator of success. Students in this study, with the exception of
Thaddeus and Manny, were fairly adept at choosing instructional methods with which they experienced success.

For learners who bring a significant history of reluctance and/or failure to the learning environment, being allowed a choice of methods with which to learn may provide the motivation needed to at least attempt academic participation.

Research Question Three

The third research question was to determine the association of instructional method and appropriate classroom behavior. Behaviors of students with EBD often interrupt or preclude learning for themselves and other students. For this reason, it is important to know which instructional methods promote more adaptive behavior. Behaviors that interfered with learning for students in this study included tardiness and unexcused absences, off-task behavior, disruptive verbal behaviors, disrespectfulness toward peers, and failing to follow directions. Classroom rules addressed these behaviors and data were collected using interval recording with regard to the instructional condition to determine if particular behaviors were more likely engaged in under particular conditions.

There was no difference in the total number of absences during the direct teach and CAI methods, and only a few more absences during the combined method. While attendance is a crucial component of learning, it appears that the instructional method in use had little impact on student attendance rates. This conclusion is logical based on these students’ challenging life conditions. The home and life conditions with which they must cope involve mental illness of siblings and parents, poverty, single-parent or absent parent homes, teen pregnancy, and parental gang affiliation. These events have such an
impact on their school performance that it is unlikely that a simple change in instructional
ccondition could mediate these effects.

Likewise, there was only a small difference in the numbers of unexcused tardies
to class for each method. There was only one tardy during the direct teach method, two
during CAI, and three during the combined approach. Because the instructional
components for direct teach and the combined approach were identical for the beginning
of class, no important information can be gleaned from this data.

There were some classroom behaviors that appeared to be correlated to
instructional method, as indicated by Table 15. During direct teach, students used
inappropriate language, topics, timing, or tone, twice as often as they did during CAI.
There were 21 intervals of this behavior during direct teach, 10 during CAI, and 8 during
the combined approach. This was likely due to the fact that during direct teach students
are in closer proximity to each other than they are during CAI, and are closer to each
other for a longer time period than they are during the combined method. Also, during
direct teach, students verbally respond as the teacher poses questions to assess
understanding. These interactions are often the stimulus for improper conversations.

There were more intervals of not following directions during the CAI method than
during other conditions. Six instances of not following directions occurred under the CAI
condition when students were caught listening to downloaded music or viewing unrelated
material on the internet instead of working on OdysseyWare® lessons. There was only
one instance of this behavior marked during the combined method and zero during direct
teach. During direct teach, teacher behaviors seem to have more impact on proactively
inhibiting misbehavior, whereas when students are working independently at computer
stations, teachers can only be reactive to discipline infractions that have already taken place.

There was only one interval of behaving disrespectfully during direct teach and none during the other two methods. This was surprising because it seemed that students would have had more opportunities to disrespect the personal space of each other while at the computer (i.e. purposely pressing keys on each other’s keyboards, turning off another student’s computer or monitor). Perhaps the previously established consequences for such behavior prohibited students from behaving in this manner. Students who infringed on someone else’s work space were prohibited from using the computer for one day.

Utilities on OdysseyWare® allow lessons and quizzes to be printed. Students were issued paper copies of CAI lessons to be done at their desk and had no email or internet privileges when work was completed.

Off-task behavior was the most frequently observed inappropriate behavior. During the combined method, there were 32 instances of off-task behavior, 46 instances during CAI, and 47 instances during direct teach. If data reflecting Thaddeus’ sleeping are removed from consideration, 41 instances of off-task behavior were noted, 20 during CAI, 10 during combined method, and 11 during direct teach. For Thaddeus, these data likely reflect his dislike for the direct teach method. For others, increased misbehavior during CAI is likely due to the difference in classroom structure during the CAI approach and the time on the computer during the combined approach. During CAI and after being released to their computer stations during the combined approach, students engaged in self-paced activities, whereas the teacher directed learning activities during direct teach.
The fact that the fewest episodes of off-task behavior occurred during the combined approach is consistent with the finding of Clarke and colleagues (1995) that by manipulating instructional and curricular variables, there is a corresponding decrease in undesirable behavior during instructional activities. The combined method was preferred by most of the students in this study, and this corresponded with the fewest instances of off-task behaviors. The combined method provides students with the structure that they know they need to be successful with the motivating value offered by the computer. While these students had historically not experienced much school success, particularly in mathematics, the combination of these critical aspects of learning provided them with an experience that contradicted their previous classroom experiences.

These behavioral data, particularly the off-task data, reflect the fact that these students need high levels of classroom structure. Students with EBD typically have poor self-regulation skills. While CAI offers a learning environment that many students enjoy and find beneficial (interactive quality, immediate feedback and grading, adjustable tools for individualization, and the ability to allow students to access instruction at the students' discretion), direct teach offers a learning environment that can be constantly adapted to meet on-going student needs. A teacher practicing the principles of direct teach constantly assesses students’ learning and makes appropriate adjustments. Further, during direct teach, the pacing of a lesson is provided for students who have difficulty regulating their own learning. The combined method offers the best of both approaches. Material is presented by a teacher who can intervene early in a cycle of misbehavior or immediately recognize signs of not understanding and provide clarification, unlike a computer that can only present information in the way in which it has been programmed.
Further, the computer can be used at the completion of teacher-mediated instruction and offer the interactive, immediate feedback and grading of assignments that is humanly impossible.

Conclusions

The following are overall conclusions drawn from this study:

(a) Research with secondary students with EBD in public school settings is difficult due to student absences that are likely the result of students escaping learning environments they have come to perceive as aversive.

(b) The combined method appeared to be the most effective instructional method for students with EBD who also have a learning disability.

(c) Emotional and behavioral variability of students with EBD result in data that can be misleading.

(d) Allowing students a choice of methods from which to learn may provide motivation for reluctant learners to at least attempt academic endeavors.

(e) While many students are adept at selecting instructional methods that result in academic success, some will require assistance in selecting a method that contributes to their success.

(f) Students were more apt to verbally disrupt class during direct teach and less likely to do so during the combined approach.

(g) Students were more likely to follow directions during direct teach and less likely to do so during the CAI approach.

(h) Students were more likely to be on-task during the combined method and less likely to be on-task during the CAI approach.
(i) The combined approach offers the necessary structure of direct teach and the motivational qualities of CAI.

Limitations

One limitation of this study was the fact that the teacher was also the researcher. Measures were taken to ensure minimal internal validity errors, including outside observers who performed reliability checks during data collection and objective dependent variables. The reliability rate for baseline measures was 100% agreement; the rate for quizzes during the intervention phase, best treatment phase, and post-instruction probe was 95%. The percent of agreement among observers to identify the instructional method in use was 100% and the rate of agreement regarding the critical components of each method was 94.8%.

Another major limitation in this study was the fact that a substantial number of data points were lost due to student absences and failure to make up missing work. Because this study involved knowledge acquisition, students were encouraged to make up the exams before instruction commenced on the next objective; however they were often unmotivated to do so. Again, these problems reflect the reality of field research with this population. Barlow and Hersen (1984) suggest at least three data points per independent variable for alternating treatments design. Only four students had all three data points for each of the three instructional methodologies. Four students lacked one data point and two of the nine students lacked three data points.

Extending the duration of the study was not feasible as this study covered one full school semester (spring semester) and students left for summer vacation the day after the post-instruction probe. During the course of one semester, the sample size dwindled from
16 participants to 10 students whose data was useable. Had the study continued into the next school year, data for an additional four students would have been lost. Crane, Bryan, Chad, and Tyrene did not return to school in the fall of the next school year. All of these students dropped out of school. The variability in behavior for this population creates these challenges to research.

Implications for Practice

This study investigated instructional methods to teach math to secondary students with EBD. For districts to comply with the federal mandates of NCLB, instructional methods must be supported by scientific research. Yet, with this population, limited research exists documenting effective instructional methods, especially for math. This study contributes to the research base so that instructional decisions can be based on a solid evidentiary foundation.

This study substantiates the difficulties of engaging in research with this population. Out of sixteen students, six (37.5%) did not complete the study. Of those who completed, seven of the ten (70%) were missing crucial data points. The poor attendance patterns that are characteristic of this population was very evident in this study. It is imperative to discover conditions under which these students are more successful and motivated to remain in school. Because this study included information about students’ preferences for various instructional methods, as well as conditions under which behavior was more appropriate, it contributes to that exploration.

Further, this study did provide evidence, though not overwhelming, that the combination of structure provided by direct teach and the motivational value of computer-assisted instruction improves academic outcomes in math. This was
particularly true for students with learning disabilities in mathematics. As students with EBD are often dually diagnosed with other disabling conditions, it is necessary for teachers to consider the totality of students’ disabilities when making instructional decisions.

As technology continues to become infused into the classroom, care must be taken to ensure the role of teacher-mediated instruction. This population of learners is not adept at self-teaching as evidenced by the increased numbers of off-task behaviors during the CAI approach and the higher mean scores for the combined method for 50% of participants and an equal mean score for the combined method and another method for an additional 20% of participants. This research suggests that teacher-directed instruction is not lost in the age of computers. While technology offers variables that are shown to enhance learning, including scaffolded, interactive learning, high levels of opportunities to respond, and immediate feedback, it alone appears incapable of teaching most students with academic gaps and high rates of variable behaviors. A combination of these methods may provide the highest levels of learning mathematics for students with EBD.

Future Research

This study serves as a basis for a much needed area of study. Additional studies should continue to investigate effective instructional methodologies for this population of learners, particularly with respect to math instruction. Because of the small number of participants and the attendance problems that plagued this study, additional studies into the effectiveness of these three methodologies need to be done to determine if the results can be replicated.
Future research should also attempt to identify specific practices within each instructional approach that contributed or detracted from the effectiveness of that approach. Varying the disaggregated components of each instructional approach while simultaneously examining the effects on math performance may reveal important information about discrete practices that contribute to students' learning. For example, future research may examine the effects of providing high rates of teacher interaction during computer-assisted instruction, or using a mastery learning approach (e.g., requiring mastery of instructional objectives before moving on to new material) during direct teach. Close examination of specific instructional practices, particularly with consideration for individual student characteristics, should facilitate identification of the most powerful instructional package for students with EBD.

Further, this study considers only one content area: mathematics. Reading and written expression are other areas where it is critical to teach students using research-based methods of instruction. For example, would the combined method be as effective in teaching writing as it was for teaching mathematics? Additionally, instructional methods that are combined with behavior management techniques need to be evaluated to determine if academic performance is enhanced for mathematics in the same way that they have been shown to be effective in reading.

Finally, because many students with EBD are being educated in inclusive classrooms with non-disabled populations, research is needed to effectively guide teachers in selecting instructional methods that are effective for increasingly diverse learners. Questions addressing effective methodologies in various instructional placements need to be explored. Comparative studies need to be conducted to determine
if the same methods are effective in more restrictive settings as they are in inclusion settings.

In summary, students with EBD arguably present significant challenges to educators. Given the complex interplay of behavioral, social, and academic difficulties characteristic of this population, it is essential that educators identify and implement efficacious interventions to improve outcomes in all of these areas. While a substantial research base exists documenting effective behavioral interventions, there is a need for research that documents effective academic interventions, particularly for math instruction. The present study addresses that need by systematically examining the effectiveness of three commonly used instructional approaches on multiple outcome variables. Results of this study suggest preliminary evidence of effectiveness of using direct teach and computer-assisted instruction in combination. In addition, additional research needs are identified. Identifying best instructional practices for students with EBD through future research, and implementing those practices in programs for students with EBD, may help improve academic and behavioral outcomes for these students.
REFERENCES


