THE EFFECTS OF SUPPLEMENTAL PERFORMANCE AND ON-TASK CONTINGENCIES ON THE ACQUISITION OF MATH SKILLS FOR ELEMENTARY SCHOOL STUDENTS WITH BEHAVIORAL DISORDERS, STUDENTS WITH ATTENTION DEFICIT DISORDERS, AND STUDENTS WITHOUT DISABILITIES

DISSERTATION

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements For the Degree of

DOCTOR OF PHILOSOPHY

BY

Cheryl L. Suter, B.S., M.Ed.
Denton, Texas
May, 1993
THE EFFECTS OF SUPPLEMENTAL PERFORMANCE AND ON-TASK CONTINGENCIES ON THE ACQUISITION OF MATH SKILLS FOR ELEMENTARY SCHOOL STUDENTS WITH BEHAVIORAL DISORDERS, STUDENTS WITH ATTENTION DEFICIT DISORDERS, AND STUDENTS WITHOUT DISABILITIES

DISSERTATION

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements For the Degree of

DOCTOR OF PHILOSOPHY

BY

Cheryl L. Suter, B.S., M.Ed.

Denton, Texas

May, 1993
Suter, Cheryl L., The Effects of Supplemental Performance and On-Task Contingencies on the Acquisition of Math Skills for Elementary School Students with Behavioral Disorders, Students with Attention Deficit Disorders, and Students without Disabilities. Doctor of Philosophy (Special Education), May 1993, 104 pp., 4 tables, bibliography, 109 titles.

Today, approximately 3 to 5% of school age children have very serious behavioral disorders, and 3 to 5% of elementary school students are medically diagnosed as having attention deficit disorders. These students often experience academic difficulties. Yet few empirical studies have targeted increasing the academic performance of students with behavioral disorders.

The purpose of this study was to investigate the effects of supplemental on-task and performance contingencies on the acquisition of math skills for elementary school children identified as seriously emotionally disturbed/behaviorally disordered, attention deficit disordered, and students without disabilities. Three experimental conditions were utilized, involving teacher-directed instruction with (a) no contingencies, (b) contingencies for academic performance, and (c) contingencies for academic performance and on-task behavior.
The study was designed to measure the effects of these contingency conditions on the number of math problems solved accurately by the study's participants.

Forty children (ages 8-11) from three public school campuses participated. Thirteen of these students had been diagnosed emotionally disturbed, 13 were medically diagnosed as having attention deficit disorders, and 14 had never been identified as in need of special education or as having attention deficit disorders. Subjects were matched on age, grade placement, gender, ethnicity, and intellectual functioning.

A two-way analysis of variance revealed significant row and column main effects and significant interaction. Overall, subjects who did not receive reinforcers solved significantly more problems correctly than subjects who earned reinforcers. In this study, subjects with behavioral disorders solved significantly fewer problems correctly than did subjects with attention deficit disorders and subjects without disabilities. However, when students with behavioral disorders received reinforcers for both on-task behavior and academic performance, their math performance equaled that of their peers without disabilities. No significant difference in math performance was found between students with attention deficit disorders and students without disabilities.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th></th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Purpose</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Significance</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Limitations</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>II. LITERATURE REVIEW</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Student Characteristics</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Effective Instruction</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Reinforcement</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Findings of Selected Studies</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>III. METHODOLOGY</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Hypotheses</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Subject Selection</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Setting</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>Experimental Design</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>Data Collection</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>Data Analysis</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>IV. RESULTS AND DISCUSSION</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>Description of Subjects</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>Tests of Assumptions</td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>Overall Findings of Significance</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Discussion</td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>V. SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>Results of the Study</td>
<td></td>
<td>57</td>
</tr>
<tr>
<td>Implications</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>Recommendations for Future Research</td>
<td></td>
<td>61</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table

1. Gender, Age, Ethnicity, and Overall IQ . . . . . . 43
2. Two-Way Analysis of Variance . . . . . . . . . . 46
3. Expanded Summary ANOVA Including Tests of Simple Effects . . . . . . . . . . . . . . . . . . . . . . . . 47
4. Scheffe' Multiple Comparison Test . . . . . . . . 49
CHAPTER I

INTRODUCTION

It is estimated that 3 to 5% of school age children have very serious emotional/behavioral disabilities (Knitzer, 1982; Knitzer, Steinberg, & Fleisch, 1990). Similarly, 3 to 5% of elementary school children are estimated to meet the diagnostic criteria for attention deficit disorder (Attention Deficit Hyperactivity Disorder Advisory Committee, 1991; Campbell & Werry, 1986). Due in part to the increasing numbers of children exposed prenatally to harmful substances, the number of students entering school with learning problems, behavior problems, and attention deficit disorders is predicted to increase (Bauer, 1991; Van Dyke & Fox, 1990).

Although it is acknowledged that different instructional strategies may be necessary for teaching academic skills to students with behavioral disorders (Hallahan & Kauffman, 1986; Kauffman & Wong, 1991), few studies have examined the academic performance of these children and youth (Lakin, 1983; Ruhl & Berlinghoff, 1992). When Ruhl and Berlinghoff (1992) searched for empirical studies published between January, 1976 and June, 1990 which targeted increasing the academic performance of students
with behavioral/emotional disorders, only 15 empirical studies were found. Findings of a national survey reveal that classroom programming for students with behavioral disorders currently emphasizes "behavioral and social skills followed by academic skills" (Grosenick, George, George, & Lewis, 1991, p. 95). When an examination is made of the academic characteristics of children and youth with behavioral disorders, it is evident that the need to improve academic performance cannot be minimized. The majority of these students have global academic deficiencies (Fessler, Rosenberg, & Rosenberg, 1991) and are functioning below grade level (Knitzer et al., 1990). Compared to all other disability areas, students with emotional disturbance/behavioral disorders are most likely to receive a failing grade and to be retained (U.S. Department of Education, 1990b; Wagner & Shaver, 1989). In addition, the highest percentage of students with disabilities who drop out of school are students with behavioral disorders (U.S. Department of Education, 1991, 1992).

The attentional problems of students with attention deficit disorders result in academic difficulties for them (Barkley, 1990; Virginia Department of Education, 1989). According to Barkley (1990), the majority of students with attention deficit disorders will develop psychiatric, academic, or social disorders by age 10. The remainder will experience problems "primarily with academic performance and
eventual educational attainment" (Barkley, 1990, p. 113). Many researchers advocate using stimulant drugs to increase the academic performance of students with attention deficit disorders (Barkley, Fischer, Newby, & Breen, 1988; DuPaul, Barkley, & McMurray, 1991; Vyse & Rapport, 1989). Rather than focusing on stimulant treatment to increase academic performance of children with attention deficit disorders, this study investigated the effects of contingent reinforcement of on-task behavior and academic performance on the acquisition of math skills for these students.

Research indicates that a functional relationship exists between attending behaviors and academic performance, particularly for low achievers (Cobb, 1972; Iwata & Bailey, 1974; Sindelar, Honsaker, & Jenkins, 1982; Soli & Devine, 1976). A number of studies have demonstrated that, by targeting and contingently reinforcing academic performance, not only does academic performance accelerate, but attending behaviors accelerate as well (Aaron & Bostow, 1978; Ardi, 1989; Ayllon, Layman, & Burke, 1972; Ayllon & Roberts, 1974; Hay, Hay, & Nelson, 1977; Kirby & Shields, 1972; Lentz, 1988; Marholin & Steinman, 1977; Winett & Roach, 1973; Winett & Winkler, 1972). However, for students who are highly distractible or students with severe behavioral problems, particularly when acquiring new skills or under difficult task conditions, it may be necessary to provide contingencies for classroom attending behavior in

Purpose

The purpose of this study was to investigate the effects of supplemental on-task and performance contingencies on the acquisition of math skills for elementary school children identified as seriously emotionally disturbed/behaviorally disordered, attention deficit disordered, and students without disabilities. In this study, three experimental conditions were utilized. These learning conditions could be replicated by general and special education teachers who work with students with behavioral disorders, students with attention deficit disorders, and/or students without disabilities. In order to control for possible teacher effects, the researcher served as the instructor and provided direct teacher instruction to all three experimental groups (Rosenberg et al., 1985).

Forty elementary school students participated in the investigation, with 12 students in the Condition A group, 15 students in the Condition B group, and 13 students in the Condition C group. Condition A involved teacher-directed instruction and independent seatwork with no contingencies provided for on-task behavior or academic performance. Condition B involved teacher-directed instruction and
independent seatwork with contingencies provided for academic performance only. Condition C involved teacher-directed instruction and independent seatwork with contingencies provided for academic performance and on-task behavior.

This study was designed to measure the effects of three learning conditions (i.e., no contingencies, performance contingencies, and on-task and performance contingencies) on the number of math problems completed accurately by students with behavioral disorders, students with attention deficit disorders, and students without disabilities.

Significance

Determining instructional strategies which effectively improve the academic performance of students with behavioral disorders and attention deficit disorders will benefit those children who are currently in the school systems as well as future students with these characteristics (Bauer, 1991; Van Dyke & Fox, 1990). Ruhl and Berlinghoff (1992) advocate further studies examining both how to improve instruction for students with behavioral disorders and "ways to motivate these students to learn versus just to behave in socially desirable ways" (p. 186). According to these authors, "there has not been a sufficient amount of research (e.g., across subjects, level, interventions) in any one subject area to guide teachers of students with behavioral disorders" (Ruhl & Berlinghoff, 1992, p. 185). This study
adds to the limited research available on math interventions for students with emotional/behavioral disorders and students with attention deficit disorders (Forness, 1989).

With an emphasis presently on educational reform and school restructuring, more authors are criticizing the current "pull-out" special education system and encouraging better integration between general and special education (Council of Chief State School Officers Resource Center on Educational Equity, 1992; Roach, 1991; Sailor, Gerry, & Wilson, 1991). Therefore, the academic status of students with various exceptionalities needs to be examined relative to their peers without disabilities (Epstein, Kinder, & Bursuck, 1989; Mastropieri, Jenkins, & Scruggs, 1985; Ruhl & Berlinghoff, 1992). By comparing the academic performance of students with disabilities to the performance of their peers without disabilities, socially valid performance standards can be established (Van Houten, 1979). Because students with attention deficit disorders are present "in almost every classroom in America" (Virginia Department of Education, 1989, p. 1) and students with behavioral disorders are increasingly being mainstreamed into general education classes (Epstein et al., 1989), studies of methods suitable for both general and special education classrooms are recommended (Ruhl & Berlinghoff, 1992). This study serves both functions, in that (a) the math skills of students with behavioral disorders and students with
attention deficit disorders are examined relative to matched peers without disabilities, and (b) the instructional methods utilized are appropriate for all classrooms.

According to Morse and Smith (1983), behavioral techniques, such as reinforcing appropriate academic responses, can be easily incorporated into classroom settings. Delivering reinforcers to some students for appropriate classroom behaviors has been demonstrated to also alter the behaviors of other students in the classroom (Kazdin, 1973). Reinforcement contingency intervention is an efficient, effective strategy for classroom management, and, possibly, for accelerating academic achievement.

Limitations

The generalizability of the results of this study may be limited to students with similar characteristics and behaviors. Marker variables (e.g., age, gender, ethnic background, intellectual functioning) are reported to provide more precise descriptions of the study's participants (Ruhl & Berlinghoff, 1992). Secondly, the students with attention deficit disorders and the students without disabilities will be matched to the students with behavioral disorders. As Drew and Hardman (1985) note, human subjects are extremely complex, making it "almost inconceivable that all the possible dimensions that may influence subject performance can be considered and controlled" (p. 180). However, subjects were matched on as
many dimensions as possible (e.g., age, grade placement, intellectual functioning, gender, ethnic background). Finally, external validity may have been threatened due to the artificial research arrangements (Drew & Hardman, 1985). An attempt was made to replicate an actual classroom setting as closely as possible to control for this potential threat.

Definition of Terms
1. **Seriously Emotionally Disturbed** as cited in 34 Code of Federal Regulations Section 300.5 (b)(8) of the Individuals with Disabilities Education Act.

   (i) The term means 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 other health factors;

   (B) An inability to build or maintain satisfactory interpersonal relationships with peers and teachers;

   (C) Inappropriate types of behavior 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.

(ii) The term includes children who are
The term does not include children who are socially maladjusted, unless it is determined that they are seriously emotionally disturbed (U.S. Department of Education, 1990a).

2. **Behaviorally Disordered** - term used interchangeably with the term "seriously emotionally disturbed".

3. **Attention Deficit Disorders** as defined in the *Diagnostic and Statistical Manual of Mental Disorders, 3rd Edition, Revised*.

   The diagnostic criteria specify that the disturbance must have been ongoing for at least 6 months, onset must have occurred prior to age 7, and at least 8 of the following 14 behaviors must be present (at considerably greater frequency than observed for most other people of the same mental age):

   1. often fidgets with hands or feet or squirms in seat (in adolescents, may be limited to subjective feelings of restlessness);

   2. has difficulty remaining seating when required to do so;

   3. is easily distracted by extraneous stimuli;

   4. has difficulty awaiting turn in games or group situations;

   5. often blurts out answers to questions before they have been completed;

   6. has difficulty following through on
instructions from others (not due to oppositional behavior or failure of comprehension), e.g. fails to finish chores

(7) has difficulty sustaining attention in tasks or play activities;

(8) often shifts from one uncompleted activity to another;

(9) has difficulty playing quietly;

(10) often talks excessively;

(11) often interrupts or intrudes on others, e.g., butts into other children's games;

(12) often does not seem to listen to what is being said to him or her;

(13) often loses things necessary for tasks or activities at school or at home (e.g., toys, pencils, books, assignments)

(14) often engages in physically dangerous activities without considering possible consequences (not for the purpose of thrill-seeking), e.g., runs into street without looking (American Psychiatric Association, 1987, pp. 52-53).
CHAPTER II

LITERATURE REVIEW

Sources cited in this review were obtained through a series of activities. First, the Current Index to Journals in Education (CIJE), was searched for references to journal articles pertaining to special education, behavioral disorders, emotional disturbance, attention deficit disorders, academic performance, and teaching characteristics. Next, a review of Dissertation Abstracts International (DAI), revealed few studies concerning academic performance and students with behavioral disorders or attention deficit disorders completed during the years 1985 to 1991. In addition, the Educational Resources Information Center (ERIC) database for years 1982 through 1992 and the PsychLIT database for years 1974 through 1992 were searched. Descriptors for these searches included behavioral disorders, attention deficit disorders, academic performance, student characteristics, teacher characteristics, reinforcement, contingencies, and special education. Finally, a hand search of monographs containing papers presented at national conferences of teachers of children and youth with behavioral disorders was conducted.
This review of the literature will begin with a description of the characteristics of students with behavioral disorders and students with attention deficit disorders. The overlap between attention deficit disorders and certain categories of disability (i.e., learning disabilities, behavioral disorders) is noted. Next, instructional strategies which facilitate students' learning are delineated. Third, positive reinforcement is discussed as a technique for increasing students' rates of correct academic responding. Finally, findings of representative studies are presented.

Student Characteristics

Students with Behavioral Disorders

National prevalence rates indicate that less than 1% of public school children are identified by educational guidelines as having behavioral and emotional problems (U.S. Department of Education, 1990b). However, epidemiologic research suggests that 7 to 10% of the school age population has behavioral problems severe or sustained enough to warrant intervention (Bradenburg, Friedman, & Silver, 1990; Forness & Knitzer, 1990, Knitzer et al., 1990), with 3 to 5% of the nation's children and youth judged to be seriously emotionally disturbed/behaviorally disordered (Knitzer et al., 1990). These children are characterized by a variety of maladaptive behaviors (e.g., fighting, hitting, uncooperativeness, short attention span, social withdrawal,
stealing, anxiety, disrespect to adults) (Epstein, Kauffman, & Cullinan, 1985; Hallahan & Kauffman, 1986; Knitzer et al., 1990; Quay, 1979). When Epstein et al. (1985) factor analyzed teacher rating data on the behaviors of 727 students identified as behaviorally disordered, the primary factor, regardless of the students' age or sex, was aggression and classroom disruption, followed by peer-oriented aggression and delinquency.

In addition to behavioral problems, students with behavioral and emotional disorders exhibit intellectual and academic deficiencies. Average overall WISC-R scores for schoolage children with behavior disorders are 90–91 (Hallahan & Kauffman, 1986; Kauffman, Cullinan, & Epstein, 1987). According to Kauffman et al. (1987), teacher rating data indicated that at least 70% of the 727 subjects with behavioral disorders were functioning below grade level across subject areas (i.e., reading recognition, reading comprehension, written expression, and arithmetic). Similarly, Fessler et al. (1991) reported that 57% of the students with behavioral disorders in their study were assessed to have academic deficiencies in all content areas (i.e., reading, written language, and math). Unfortunately, these academic deficits only increase over time, unless effective academic interventions are implemented (Coutinho, 1986; Cullinan, Epstein, & Lloyd, 1983; Epstein et al., 1989; U.S. Department of Education, 1990b; Wagner & Shaver,
Because students who performed better in arithmetic were found to receive a greater degree of mainstreaming (Kauffman et al., 1987), interventions which increase arithmetic performance are appropriate and socially valid (Van Houten, 1979) for students with behavioral disorders.

**Students with Attention Deficit Disorders**

Research estimates that 3 to 5% of school age children meet the diagnostic criteria for attention deficit hyperactivity disorder (Attention Deficit Hyperactivity Disorder Advisory Committee, 1991; Campbell & Werry, 1986; Virginia Department of Education, 1989). Applying these estimates, 57,000 to 95,000 elementary school children in Texas (approximately one child in every classroom) meet the criteria for attention deficit hyperactivity disorder (Attention Deficit Hyperactivity Disorder Advisory Committee, 1991). If teacher ratings are used to identify students with attention deficit disorders, prevalence rates increase to 10 to 20% of the school age population (Shaywitz & Shaywitz, 1988). These children and youth are characterized by distractibility, short attention span, impulsivity, hyperactivity, difficulty completing work, disorganization, and aggression (Attention Deficit Hyperactivity Disorder Advisory Committee, 1991; Holmes, 1987; Lerner & Lerner, 1991; Shaywitz & Shaywitz, 1988). These characteristics often continue to describe individuals with attention deficit disorders after they reach adulthood.
The attentional difficulties which characterize students with attention deficit disorders interfere with their ability to master academic tasks (Shaywitz & Shaywitz, 1988). According to Barkley (1990), adolescents with attention deficit hyperactivity disorders are three times as likely to have failed a grade as their nondisabled peers. On standardized achievement tests, this same sample of adolescents performed "significantly below normal on tests of math, reading, and spelling" (Barkley, 1990, p. 119). Similarly, significantly lower reading, spelling, and math achievement scores were found for elementary school children with attention deficit disorders than for controls (Carlson, Lahey, & Neeper, 1986). Zentall (1990) explains that the difficulties children with attention deficit disorders have in attending to repetitive stimuli contribute not only to their basic math skill deficits, but also to math problem solving deficits. Because "long-term problems for these children in both basic and higher level mathematics" (Zentall, 1990, p. 864) can be anticipated, interventions which increase arithmetic performance are appropriate and socially valid (Van Houten, 1979) for students with attention deficit disorders.

Overlap Between Attention Deficit Disorders and Categories of Disability

In Public Law 101-476, the Individuals with
Disabilities Education Act (IDEA), attention deficit disorders is not recognized as a separate category of disability (Attention Deficit Hyperactivity Disorder Advisory Committee, 1991; Lerner & Lerner, 1991; Virginia Department of Education, 1989). Students with attention deficit disorders who do not qualify for special education and related services as learning disabled or emotionally disturbed/behaviorally disordered but whose educational performance is adversely affected by the attention deficit disorder can qualify for special education services in one of two ways. First, students whose primary disability is attention deficit disorders can qualify for special education under the Individuals with Disabilities Education Act as "other health impaired" (Lerner & Lerner, 1991; Virginia Department of Education, 1989). Additionally, any child between the ages of 3 and 21 whose attention deficit disorder substantially impairs his or her educational performance or ability to learn can qualify for special education under Section 504 of the Rehabilitation Act of 1973 (Lerner & Lerner, 1991).

The overlap between attention deficit disorders and certain disability areas (i.e., learning disabilities, behavioral disorders) is widely acknowledged (Fletcher, Morris, & Francis, 1991; Lerner & Lerner, 1991; Pelham & Murphy, 1986; Shaywitz & Shaywitz, 1988; Virginia Department of Education, 1989). According to Shaywitz and Shaywitz
(1988), approximately 50% of students identified with attention deficit hyperactivity disorders have specific learning disabilities. One study demonstrated that children with attention deficit disorders who were not taking medication were difficult to differentiate from children with learning disabilities (Cherkes-Julkowski & Stolzenger, 1991). In addition, between 30 to 90% of students with attention deficit disorders also have significant behavioral problems (Frick & Lahey, 1991; Lerner & Lerner, 1991). The co-occurrence of serious emotional disturbance and attention deficit hyperactivity disorder is reported to be 30 to 65% (Pelham & Murphy, 1986; Virginia Department of Education, 1989).

Some researchers state that attention deficit disorder is "an inadequately specified category" (Rubinstein & Brown, 1984). Because of this overlap between attention deficit disorders and the disability categories of learning disabilities and serious emotional disturbance/behavioral disorders, quantitative studies of students with attention deficit disorders often use "samples that are poorly defined in terms of their relationship with the population of all children who have problems" (Fletcher et al., 1991, p. 74). For these reasons, it is imperative that the samples of students used in empirical studies of attention deficit disorders be as precisely described as possible (Fletcher et al., 1991).
Effective Instruction

Teacher effectiveness research indicates a number of instructional strategies that facilitate students' learning. Some of these instructional strategies are derived from direct instruction, which has been found in efficacy studies to produce greater academic gains than other forms of instruction with which it was compared (Gersten, 1985; Lloyd, Cullinan, Heins, & Epstein, 1980; White, 1988; Wilson & Sindelar, 1991). Some principles of direct instruction include brisk pacing of lessons (Englert, 1984; Englert, Tarrant, & Mariage, 1992; Kinder & Carnine, 1991; Nowacek, McKinney, & Hallahan, 1990), providing immediate, academically oriented student feedback (Brophy, 1986; Englert, 1984; Kinder & Carnine, 1991; Skinner, Ford, & Yunker, 1991), using adequate, structured student practice (Englert, 1984; Gersten, Carnine, & Woodward, 1987; Kinder & Carnine, 1991; Maroney & Smith, 1990), and maintaining high levels of student responding (Englert et al., 1992; Maroney & Smith, 1990; Skinner et al., 1991). Other effective teaching strategies include (a) providing ample instructional time (Englert et al., 1992; Rieth, Polsgrove, Semmel, & Cohen, 1980), (b) orienting students to the lesson content, (c) active teacher modeling of problem-solving procedures in the content area, and (d) continually monitoring student progress (Englert et al., 1992; Morsink, Thomas, & Smith-Davis, 1987). The term "teacher-directed
instruction" is used by Morsink et al. (1987) to include all effective instructional strategies; this term will be used in this study in the same way. Nowacek et al. (1990) found that more competent elementary teachers "exhibit behaviors associated with teacher-directed learning" (p. 147), affirming the appropriateness of this type of instruction with the subjects included in this research study.

Some researchers believe the instructional strategies described above are equally appropriate for all students, regardless of their designated category of disability (Fessler et al., 1991; G. Manifesto, personal communication, July 25, 1992; Morsink et al., 1987). Others believe specialized, individualized instruction above and beyond standard instructional practices is necessary for students with special needs (Forness, 1981; Knoblock, 1983). According to Englert (1984), students who lack selective attention skills (e.g., students with attention deficit disorders) benefit from focusing or precueing techniques in addition to the aforementioned instructional strategies. Because studies of teacher effectiveness rarely include students with emotional or behavioral disorders, Kauffman and Wong (1991) state that "the distinctive features of effective teachers of students with behavioral disorders remain hypothetical" (p. 226). They maintain that research is needed to determine which teaching strategies are effective for students with behavioral disorders (Kauffman &
This study contributes to the information available on effective teaching strategies for both students with attention deficit disorders and students with behavioral disorders.

Reinforcement

Positive reinforcement is defined by Alberto and Troutman (1990) as "the contingent presentation of a stimulus, immediately following a response, that increases the future rate and/or probability of the response" (p. 191). To determine the events or objects that will function to increase rates of correct academic responding, student behavior may be observed preliminarily (Gallagher, 1988) and a reinforcer menu prepared, from which students rank order their reinforcers (Alberto & Troutman, 1990). Once reinforcers have been chosen by the students, they must be delivered immediately following the occurrence of the target behavior. The size of the reinforcer must be large enough for the student to consider it worthwhile to emit the desired behavior, and the reinforcer must not be delivered so frequently that the student satiates on it (Alberto & Troutman, 1990). In the proposed study, generalized conditioned reinforcers (e.g., tokens, points, poker chips) will be used and accumulated by the students, then exchanged for back-up reinforcers to avoid satiation on the reinforcers available (Alberto & Troutman, 1990; Linn, 1983). Reinforcement, in the form of positive teacher
attention and the use of tokens, is advocated when instructing students with attention deficit disorders (Abramowitz & O'Leary, 1991; Attention Deficit Hyperactivity Disorder Advisory Committee, 1991; Barkley, 1990; Lerner & Lerner, 1991) and when teaching students with behavioral disorders (Gallagher, 1988: Riester, 1984).

Findings of Selected Studies

Stimulant Treatment and Performance

Studies indicate that stimulant drugs enhance the academic performance or increase academic productivity of students with attention deficit disorders (Barkley et al., 1988; DuPaul et al., 1991; Famularo & Fenton, 1987; Swanson, Cantwell, Lerner, McBurnett, & Hanna, 1991; Vyse & Rapport, 1989) and students with conduct disorders (Brown, Jaffe, Silverstein, & Magee, 1991). Other researchers believe that stimulant therapies have yet to prove sufficiently effective in the area of academic achievement (Whalen & Henker, 1991). They maintain that although stimulant treatment may influence academic productivity by increasing attention, medication has little effect on student acquisition of new skills (Hallahan & Kauffman, 1986; Virginia Department of Education, 1989). According to Pelham (1986), stimulant treatment alone does not alter the long-term prognosis of students with attention deficit disorders.

In an empirical study Chase and Clement (1985) compared the effects of self-reinforcement and stimulant treatment on
the academic performance of six male subjects, aged 9-12, diagnosed as attention deficit hyperactivity disordered. Each subject worked under several treatment conditions in a series of single subject studies. These experimental conditions included (a) methylphenidate plus noncontingent reinforcers, (b) methylphenidate plus self-reinforcement, and (c) self-reinforcement plus placebo. Results indicate that methylphenidate alone failed to improve academic productivity or accuracy of answers to questions on daily reading assignments; whereas, self-reinforcement did improve academic performance. According to Chase and Clement (1985), slightly greater academic gains were produced by a combination of stimulant treatment and self-reinforcement than by self-reinforcement alone.

In contrast, Thompson, Gickling and Havertape (1983) compared the effects of medication and curriculum on the task-related behaviors of students with attention deficit disorders and their low-achieving peers. In this study, medication did not significantly increase task completion or task comprehension for students with attention deficit disorders. Instead, controlled instruction greatly improved task completion and comprehension for the study's participants.

**Applying Contingencies to Improve Academic Performance**

**Students with behavioral disorders.** Ardi (1989) examined the effects of reinforcing on-task behavior and
academic performance on the attending behavior and reading performance of children with behavioral disorders. Results of both a single subject design and a nonparametric statistical analyses demonstrated that reinforcing on-task behavior reduced the frequency of disruptive classroom behaviors but had little effect on the students' academic performance. Reinforcing academic behaviors, however, increased reading performance and decreased the frequency of disruptive behaviors.

Pfiffner and O'Leary (1987) investigated the effect of an all-positive contingency management system on the math problem-solving behavior of eight children, grades 1-3. Six of the eight children were reported to have behavior problems. The experimental conditions under which the subjects worked included (a) regular positives alone, (b) enhanced positives alone, (c) enhanced positives and negatives, (d) enhanced positives alone, and (e) enhanced positives and fading negatives. Results indicated that the number of arithmetic problems completed by the study's participants remained fairly consistent across experimental conditions, indicating the importance of targeting not only on-task behavior but also academic behavior for students with behavioral disorders.

Rieth, Polsgrove, Raia, Patterson, and Buchman (1977) examined the effectiveness of using contingently awarded free time to increase the reading achievement of students
with behavioral disorders. Three male subjects, aged 7-11, participated in the single subject study, in which a reversal design was utilized. For one child, contingent free time increased the number of sight vocabulary words identified on the weekly exams. For the second subject, both reading accuracy and reading comprehension scores increased as a result of using free time as a reinforcer. The number of reading assignments completed and the accuracy of these assignments improved for the third participant under the contingent free time system.

The effects of two reinforcement contingencies on the acquisition of simple and difficult mathematic tasks were compared by Rosenberg et al. (1985). In the first treatment condition, only correct answers were reinforced. In the second condition, both correct answers and attending behaviors were reinforced. Forty-four elementary school children, 8-12.5 years of age, participated. All subjects were diagnosed as either emotionally disturbed/behaviorally disordered, learning disabled, or educable mentally retarded, and all were receiving special education services. Prior to the experiment, a momentary time sampling procedure was conducted to ensure that the rate of on-task behavior for each subject did not exceed 60% during independent seatwork activities. Results of this investigation indicate that, for simple tasks, contingencies for academic performance alone "can and do result in desired levels of
academic performance" (Rosenberg et al., 1985, p. 201). However, for difficult tasks, an attentional contingency component is necessary, in addition to the performance contingency, to maintain high rates of on-task behavior and correct responding.

Students with attention deficit disorders. Ayllon and Roberts (1974) attempted to reduce disruptive behaviors in five fifth-grade boys by reinforcing academic performance. These boys were chosen for participation in the study because they were independently ranked by two teachers as being the most disruptive in the class (e.g., frequently out of seat without teacher's permission, talking out, intruding on or interrupting another student's studying). Contingently reinforcing academic performance not only resulted in increased reading accuracy for all participants, but also decreased frequency of concurrent disruptive behaviors.

Kirby and Shields (1972) examined the effects of immediate praise and correctness feedback on the arithmetic response rate and attending behavior of a seventh-grade boy. An adjusting fixed-ratio reinforcement schedule was utilized, beginning with praise and correctness feedback for every two math problems completed. Using a reversal design, Kirby and Shields (1972) found that contingent reinforcement and performance feedback increased the rate of correctly solving math problems while decreasing non-attending
behaviors.

Douglas and Parry (1983) studied "the effects of the administration of continuous, partial, and noncontingent reward, and the withdrawal of reward, on the performance of hyperactive children" (p. 314). Thirty-three elementary school students diagnosed as hyperactive and 33 matched controls participated in the study. A delayed reaction time task was administered to subjects under one of the three possible reward schedules. Data were analyzed using analysis of variance procedures. Control subjects demonstrated improved reaction times under all reinforcement conditions. Children with attention deficit hyperactivity disorders, on the other hand, improved mean reaction times under contingent continuous reinforcement conditions but not under the noncontingent schedule of reinforcement. Therefore, Douglas and Parry (1983) caution that "erratic or inconsistent reward can impair the performance of hyperactive children" (p. 323), but carefully chosen and implemented reinforcement procedures may enhance attending and performance of children with attention deficit hyperactivity disorder.

Other school age populations. Not only have reinforcement contingencies improved selective attention for students with learning disabilities (Hallahan, Tarver, Kauffman, & Graybeal, 1978), but also academic performance (Speltz, Shimamura, & McReynolds, 1982). Twelve children
with learning disabilities, 7 to 10 years old, participated in a study of the effects of individualized and group contingencies on correct completion of arithmetic problems (Speltz et al., 1982). The four treatment conditions were presented in counterbalanced order and included (a) individualized contingency, (b) all-member group contingency, (c) identified responder group contingency, and (d) unidentified responder group contingency. These contingencies were found to be equally effective in improving math performance, with the subjects as a group increasing their performance "by more than 66% during the reinforcement contingencies" (Speltz et al., 1982, p. 540).

Students with educable mental retardation have also been the subjects of research on improving academic performance through reinforcement contingencies (Aaron & Bostow, 1978; Ayllon et al., 1972; Winett & Roach, 1973). In all three studies, contingently reinforcing academic performance only resulted in increases in academic productivity, accuracy, and attending behaviors while decreasing disruptive behaviors (Aaron & Bostow, 1978; Ayllon et al., 1972; Winett & Roach, 1973). Aaron and Bostow's study (1978) also reported increases in academic productivity for most nontarget children in the class. This supports Kazdin's (1973) findings that contingently reinforcing the behavior of some students in a classroom will also alter the behavior of other students in the
Kelley and Stokes (1982) investigated the use of contingency contracting with 13 adolescents enrolled in a vocational training program. These students were between 16 and 21 years of age, and they had all dropped out of high school. The student-teacher contracts targeted academic productivity directly, with pay contingent on contract fulfillment. Results of this study demonstrated that student productivity more than doubled during the contingent contracting phase, and students' task-oriented behavior increased as well.

Hay et al., (1977) assessed the effects of reinforcing on-task behavior or academic performance on students' academic and attending behaviors. Ten boys without disabilities in grades 2-4 participated in the investigation, which was conducted in a natural classroom setting. In agreement with Ardi's (1989) findings, reinforcing on-task behavior increased attending behavior but did not increase the rate or accuracy of academic behavior. In contrast, reinforcing academic performance substantially increased the rate and accuracy of academic behavior and also considerably increased on-task behavior. Hay et al. (1977) concluded from their results that "the more parsimonious classroom intervention strategy was the explicit reinforcement of academic performance" (p. 438).
CHAPTER III

METHODOLOGY

This study was conducted to investigate the effects of performance contingencies alone and combined on-task and performance contingencies on the rate of correct academic responses of elementary school children with behavioral disorders, elementary school children with attention deficit disorders, and elementary school children without disabilities. This chapter describes the methodology for the study. Chapter organization is as follows: (a) hypotheses, (b) subject selection, (c) setting, (d) experimental design, (e) data collection, and (f) data analysis.

Hypotheses

In order to determine the effects of supplemental on-task and academic performance contingencies on the math performance of elementary school students with behavioral disorders, attention deficit disorders, and students without disabilities, two hypotheses were developed to determine if significant differences existed between the behaviors of these three types of students across three experimental conditions.
Hypothesis 1

There is a significant difference in math performance between students with behavioral disorders, students with attention deficit disorders, and students without disabilities across different contingency conditions.

Hypothesis 2

There is a significant difference in student math performance when teacher-directed instruction is accompanied by no contingencies, contingencies for academic performance alone, or contingencies for on-task behavior and academic performance.

Subject Selection

Forty elementary public school children were selected to participate in the investigation. All participants in this study were attending classes on three elementary school campuses within three suburban school districts in north central Texas. The Condition A group met on one campus with 12 students participating. The Condition B group was conducted on another campus with 15 students participating, and the Condition C group was held on the third campus with 13 students participating. Of the total group of 40, 13 students had been diagnosed as emotionally disturbed and were enrolled full- or part-time in special education classes, and 13 students had been medically diagnosed as having attention deficit disorders and were not enrolled in special education classes. The remaining 14 students were
attending general education classes and had never been identified as in need of special education and services or as having attention deficit disorders.

Permission to conduct this investigation was obtained from the special education director and administrators in each school district as well as the parents of each student selected to participate. District administrators, nurses, and teachers assisted in identifying subjects for this study. Students ranged in age from 8 to 11 years, and were matched on age, ethnicity, gender, intellectual functioning, and grade placement. On each elementary school campus, five students with behavioral disorders, five students with attention deficit disorders, and five students without disabilities were matched for participation in the experiment.

Setting

On each campus, participants were excused from their classes to attend one introductory session and four experimental sessions. These sessions were held in a room equipped with 15 desks and a chalkboard.

Experimental Design

Forty subjects were assigned to three experimental conditions, with 12 students in experimental Condition A, 15 students in experimental Condition B, and 13 students in experimental Condition C. Each group of students received instruction on four consecutive days. In order to control
for possible teacher effects, the researcher served as the instructor for all three experimental groups.

The four experimental sessions were held at different times during the school day. Varying session times and conducting the investigation on four consecutive school days provided control for the possible effects of history, maturation, and time of day (Campbell & Stanley, 1963; Rosenberg et al., 1985). Each session lasted 16 minutes. Each session consisted of 8 minutes of teacher-directed instruction and 8 minutes of independent math seatwork.

Prior to the first experimental session, a 16-minute introductory session was held with each group of students. During this session, the researcher introduced herself and asked the students to introduce themselves. The researcher told the students the purpose of the study, namely, to see how many math problems they could solve correctly during each experimental session. A 12-item worksheet was distributed (See Appendix A), and the students were asked to solve as many of the problems as they could on the worksheet. This worksheet provided information regarding the existing knowledge base of the participants. Also, for the two groups whose problem solving behavior was contingently reinforced, reinforcer menus were distributed during the introductory session (See Appendix B). Reinforcer choices included such items as peanuts, fruit snacks, baseball cards, stickers, and colorful pencils.
Students rank ordered these items according to preference (Alberto & Troutman, 1990). Students in the Condition B group were told that they would be earning tokens for solving problems correctly during the next four days of the experiment, and that they would have the opportunity to exchange the tokens they earned for the back-up reinforcers of their choice at the end of each experimental session. Students in the Condition C group were told that they would be earning tokens for staying on-task and for solving problems correctly during the next four days of the experiment. These subjects also had the opportunity to exchange the tokens they earned for the back-up reinforcers of their choice at the end of each experimental session.

For the purposes of this study, "on-task behavior" during the independent seatwork was defined as looking at the worksheet or writing on the worksheet. All other behavior was considered off-task. An observer was present during each experimental session conducted with the Condition C group. This observer sat in the room, approximately 10 feet away from the students during the teacher-directed instruction. She was equipped with a data collection sheet, a portable tape recorder, and an earphone. A round-robin format (Cooper, 1981) of time sampling was used by the observer to obtain data on the on-task behavior of the Condition C group subjects during independent seatwork. At the end of each 15-second interval, when a
tape recorded tone sounded, the observer recorded as either on-task or off-task the behavior of the student designated for observation during that interval.

The math problems to be solved by all students involved the concept of exponential notation. Worksheets were developed similar to those utilized in Rosenberg et al.'s (1985) study (See Appendix C). Rosenberg et al. (1985) found that distractible students who were assigned exponential notation problems (which they described as a difficult task) achieved significantly higher scores on the measure of overall percent correct when on-task behavior and academic performance were reinforced as opposed to reinforcement for academic performance alone. Four tasks related to the concept of exponential notation were targeted for instruction: (a) identification of base or exponent when presented with a number written in exponential notation, (b) expanding a number written in exponential notation into a series of factors, (c) renaming a series of factors as a number written in exponential notation, and (d) "renaming the product of two numbers with like bases and different exponents as a term with the same base and an exponent equal to the sum of the two exponents" (Rosenberg et al., 1985, p. 192).

Experimental Session 1

During the first experimental session, the first two tasks (i.e., identification of base or exponent when
presented with a number written in exponential notation and expanding a number written in exponential notation into a series of factors) were taught. Every student in each group had an opportunity to respond orally to both types of problems, and students were told immediately whether or not their responses were correct. When a student responded incorrectly, he or she was told the correct answer and was given another opportunity to respond to a similar problem. This procedure was repeated until each student was responding correctly to problems posed.

**Condition A.** During the teacher-directed instruction, students were told "correct" or "incorrect" when they responded orally to exponential notation problems. No praise or reinforcers were provided for correct responses. Similarly, during independent seatwork, the researcher rotated around the room but did not comment on anyone's work nor provide any reinforcers to the students as they worked.

**Condition B.** During the teacher-directed instruction, students were told "correct" or "incorrect" when they responded orally to exponential notation problems presented. In addition, each student received a poker chip when he or she responded correctly to a math problem. Similarly, during the independent seatwork, the researcher rotated around the room and gave students tokens when the last problem they solved was correct. The researcher dropped a token on the student's desk and walked away.
Condition C. During teacher-directed instruction, students were told "correct" or "incorrect" when they responded orally to exponential notation problems. In addition, each student received a poker chip when he or she responded correctly to a math problem. Similarly, during independent seatwork, the researcher rotated around the room and gave students tokens when the last problem they solved was correct. The researcher dropped a token on the student's desk and walked away.

During teacher-directed instruction, the observer sat in the room but did not interact with the students. During independent seatwork, she rotated around the room and awarded tokens to the students who were on-task (i.e., looking at their worksheets or writing on their worksheets) at the end of each interval in which their behavior was observed. She dropped a token on the desk of each student who was working on the task and walked away.

Experimental Session 2

During the second experimental session, the next two tasks (i.e., renaming a series of factors as a number written in exponential notation and multiplying two numbers with like bases and different exponents) were taught. Every student in each group was provided opportunities to respond orally to problems of both types, and students were told immediately whether or not their responses were correct. When a student responded incorrectly, he or she was told the
correct answer and was given another opportunity to respond to a similar problem. This procedure was repeated until each student was responding correctly to problems posed.

**Condition A.** During teacher-directed instruction, students were told "correct" or "incorrect" when they responded orally to exponential notation problems. No praise or reinforcers were provided for correct responses. Similarly, during independent seatwork, the researcher rotated around the room but did not comment on anyone's work nor provide any reinforcers to the students as they worked.

**Condition B.** During teacher-directed instruction, students were told "correct" or "incorrect" when they responded orally to exponential notation problems posed. In addition, each student received a poker chip when he or she responded correctly to a math problem. Similarly, during independent seatwork, the researcher rotated around the room and gave students tokens when the last problem they solved was correct. Then, the researcher walked away.

**Condition C.** During teacher-directed instruction, students were told "correct" or "incorrect" when they responded orally to exponential notation problems. In addition, each student received a poker chip when he or she responded correctly to a math problem. Similarly, during independent seatwork, the researcher rotated around the room and gave students tokens when the last problem they solved was correct. Then, the researcher walked away.
During teacher-directed instruction, the observer sat in the room but did not interact with students. During independent seatwork, she rotated around the room and awarded tokens to the students who were on-task (i.e., looking at their worksheets or writing on their worksheets) at the end of intervals in which their behavior was observed. She dropped a token on the desk and walked away.

**Experimental Sessions 3 and 4**

During the third and fourth experimental sessions, practice was provided on all four types of exponential notation problems. Every student in each group had an opportunity to respond orally to these problems, and students were told immediately whether or not their responses were correct. When a student responded incorrectly, he or she was given the correct answer and another opportunity to respond to a similar problem. This procedure was repeated until each student was responding correctly to problems posed.

**Condition A.** During teacher-directed instruction, students were told "correct" or "incorrect" when they responded orally to exponential notation problems. No praise or reinforcers were provided for correct responses. Similarly, during independent seatwork, the researcher rotated around the room but did not comment on anyone's work nor provide any reinforcers to the students as they worked.

**Condition B.** During teacher-directed instruction,
students were told "correct" or "incorrect" when they responded orally to exponential notation problems. In addition, each student received a poker chip when he or she responded correctly to a math problem. Similarly, during independent seatwork, the researcher rotated around the room and gave students tokens when the last problem they solved was correct. The researcher dropped the token on the student's desk and walked away.

**Condition C.** During teacher-directed instruction, students were told "correct" or "incorrect" when they responded orally to exponential notation problems posed. In addition, each student received a poker chip when he or she responded correctly to a math problem. Similarly, during independent seatwork, the researcher rotated around the room and gave students tokens when the last problem they solved was correct. Then, the researcher walked away.

During teacher-directed instruction, the observer sat in the room but did not interact with the students. During independent seatwork, she rotated around the room and awarded tokens to the students who were on-task (i.e., looking at their worksheets or writing on their worksheets) at the end of intervals in which their behavior was observed. She dropped a token on the desk and walked away.

**Data Collection**

At the end of each of the four experimental sessions, the worksheets of all 40 students from the three
experimental groups were collected. The number of problems solved correctly (i.e., raw scores) was calculated and recorded for each subject.

Data Analysis

The dependent variable in this study was the number of exponential notation problems solved correctly during independent seatwork. The two independent variables were the types of students participating in the study and the contingency conditions under which the students worked. In order to analyze the raw scores for significant main effects, a two-way analysis of variance (ANOVA) was applied (Ferguson, 1981; Hinkle, Wiersma, & Jurs, 1988; Kachigan, 1986; Kerlinger, 1986).
CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this study was to examine the effects of supplemental performance and on-task contingencies on the acquisition of math skills for elementary school children identified as seriously emotionally disturbed/behaviorally disordered, attention deficit disordered, and students without disabilities. In this study, three experimental conditions were utilized. Condition A involved teacher-directed instruction and independent seatwork with no contingencies provided for on-task behavior or academic performance. Condition B involved teacher-directed instruction and independent seatwork with contingencies provided for academic performance only. Condition C involved teacher-directed instruction and independent seatwork with contingencies provided for academic performance and on-task behavior. The results of this study are presented as follows: (a) description of subjects, (b) tests of assumptions, (c) overall findings of significance, and (d) discussion.

Description of Subjects

The subjects for the study (N = 40) were drawn from the
population of students attending three elementary public school campuses within three suburban school districts in north central Texas. On each campus, the school principal was asked to select five students who were diagnosed emotionally disturbed and enrolled full- or part-time in special education classes to participate in the study. These students had to be between the ages of 8 and 12, and as similar in age as possible. The school principal was then asked to match five students who had been medically diagnosed as having attention deficit disorders and five students who had never been identified as in need of special education or as having attention deficit disorders to the five students with behavioral disorders on these dimensions: age, grade placement, ethnicity, intellectual functioning, and gender. Because some of the parents indicated they did not want their children to participate in the study and some of the students chose not to participate, experimental Condition A consisted of 12 students and experimental Condition C consisted of 13 students. Experimental Condition B consisted of 15 students. Gender, age, ethnicity, and overall IQ scores for the study subjects are depicted in Table 1. When describing ethnicity, Caucasian is denoted by the letter C, Black is denoted by the letter B, and Hispanic is denoted by the letter H.
Table 1

Gender, Age, Ethnicity, and Overall IQ

<table>
<thead>
<tr>
<th>Condition</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Behavioral Disorders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>3 males, 1 female</td>
<td>5 males</td>
<td>4 males</td>
</tr>
<tr>
<td>Average Age</td>
<td>10-7</td>
<td>10-3</td>
<td>10-11</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>3 C*, 1 B*</td>
<td>5 C</td>
<td>4 C</td>
</tr>
<tr>
<td>Overall IQ</td>
<td>No scores</td>
<td>99</td>
<td>101</td>
</tr>
<tr>
<td>Students with Attention Deficit Disorders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>2 males, 2 females</td>
<td>5 males</td>
<td>4 males</td>
</tr>
<tr>
<td>Average Age</td>
<td>10-10</td>
<td>9-10</td>
<td>9-10</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>3 C, 1 H*</td>
<td>5 C</td>
<td>4 C</td>
</tr>
<tr>
<td>Overall IQ</td>
<td>99</td>
<td>96</td>
<td>109</td>
</tr>
<tr>
<td>Students without Disabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>3 males, 1 female</td>
<td>5 males</td>
<td>5 males</td>
</tr>
<tr>
<td>Average Age</td>
<td>10-5</td>
<td>10-2</td>
<td>9-9</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>4 C</td>
<td>5 C</td>
<td>5 C</td>
</tr>
<tr>
<td>Overall IQ</td>
<td>104</td>
<td>98</td>
<td>98</td>
</tr>
</tbody>
</table>

* C = Caucasian  
  B = Black  
  H = Hispanic
An inspection of Table 1 reveals the demographic characteristics of the students participating in the study. Condition A included 8 males and 4 females, while Conditions B and C included only males. The average age in each group was similar, ranging from 9 years, 9 months to 10 years, 11 months. The majority of the students in this study were Caucasian (95%), with 1 Black student and 1 Hispanic student participating in experimental Condition A. Average overall IQ scores were similar for each group, with a range of 96 to 109. For the students with behavioral disorders in Condition A, IQ scores were not available. According to the school principal, these students were unable to be tested due to their disability.

Tests of Assumptions

Three assumptions underlie the use of two-way ANOVA. These assumptions are as follows: (a) observations are random, independent samples from the populations, (b) scores on the dependent variable are normally distributed in the population, and (c) variances of the distributions in the populations are equal (i.e., homogeneity of variance) (Hinkle et al., 1988). In this study, students with behavioral disorders were selected to participate, and students with attention deficit disorders and students without disabilities who had similar demographic characteristics were then selected to participate.

Plotting the observations in each cell indicated some
skewness in the distributions. According to Hinkle et al. (1988), two-way ANOVA is robust with respect to the violation of the assumption of normal distribution of the dependent variable, and "when the populations sampled are not normal, the effect on the Type I error rate is minimal" (p. 347).

When the population variances were calculated, differences were found. Violation of the assumption of homogeneity of variance can be serious, particularly when the sample sizes are unequal (Hinkle et al., 1988). Therefore, the method of unweighted means was utilized to adjust the data for unequal cell frequencies (Ferguson, 1981). The method of unweighted means is an analysis of variance applied to the means of the subclasses (Ferguson, 1981). Both Ferguson (1981) and Rankin (1974) advocate the use of this method to adjust for unequal number of observations in the cell frequencies. By adjusting the data to account for unequal cell frequencies, the effect of heterogeneity of variances on the Type I error is minimized (Hinkle et al., 1988).

Overall Findings of Significance

A thorough investigation of the data collected on the 40 subjects was conducted using Statistics With Finesse (Bolding, 1989). The results were then adjusted for unequal cell frequencies using the method of unweighted means (Ferguson, 1981). Table 2 presents the overall findings.
### Table 2

Two-Way Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Sqr.</th>
<th>df</th>
<th>Var. Est.</th>
<th>F-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>7443.91</td>
<td>2</td>
<td>3721.96</td>
<td>6.73**</td>
</tr>
<tr>
<td>Conditions</td>
<td>17482.65</td>
<td>2</td>
<td>8741.33</td>
<td>15.81***</td>
</tr>
<tr>
<td>Interaction</td>
<td>618.51</td>
<td>4</td>
<td>1904.63</td>
<td>3.44*</td>
</tr>
<tr>
<td>Within Cell</td>
<td>79638.48</td>
<td>144</td>
<td>533.05</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>112183.55</td>
<td>152</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .01. **p < .001. ***p < .0001.

Examination of Table 2 reveals that all three F ratios exceed their respective critical values. For the row main effect (students), the conclusion is that, in the population, the mean for students with behavioral disorders differs from the mean for students with attention deficit disorders which differs from the mean for students without disabilities. For the column main effect (conditions), the conclusion is that, in the population, the means for the three contingency conditions differ. For the interaction, the conclusion is that, in the population, there is an interaction between the contingency conditions and the three types of students. Because a significant F ratio was found for the interaction, a test of simple effects was used to interpret the interaction. Table 3 presents the expanded
ANOVA table, which includes the sums of squares for the tests of simple effects.

Table 3
Expanded Summary ANOVA Including Tests of Simple Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Sqr.</th>
<th>df</th>
<th>Var. Est.</th>
<th>F-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>7443.91</td>
<td>2</td>
<td>3721.96</td>
<td>6.73**</td>
</tr>
<tr>
<td>at Cond. A</td>
<td>7109.71</td>
<td>2</td>
<td>3554.87</td>
<td>6.67*</td>
</tr>
<tr>
<td>at Cond. B</td>
<td>6308.04</td>
<td>2</td>
<td>3154.02</td>
<td>5.92*</td>
</tr>
<tr>
<td>at Cond. C</td>
<td>1486.90</td>
<td>2</td>
<td>743.45</td>
<td>1.39</td>
</tr>
<tr>
<td>Conditions</td>
<td>17482.65</td>
<td>2</td>
<td>8741.33</td>
<td>15.81**</td>
</tr>
<tr>
<td>at ED/BD</td>
<td>6398.91</td>
<td>2</td>
<td>3199.46</td>
<td>6.00*</td>
</tr>
<tr>
<td>at ADD</td>
<td>13499.67</td>
<td>2</td>
<td>6749.84</td>
<td>12.66*</td>
</tr>
<tr>
<td>at Without Disability</td>
<td>4250.50</td>
<td>2</td>
<td>2125.25</td>
<td>3.99</td>
</tr>
<tr>
<td>Interaction</td>
<td>7618.51</td>
<td>4</td>
<td>1904.63</td>
<td>3.44**</td>
</tr>
<tr>
<td>Within Cell</td>
<td>79638.48</td>
<td>144</td>
<td>533.05</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>112183.55</td>
<td>152</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .017.  **p < .05.

Examination of Table 3 reveals the results of the analysis of the simple effects. For the students at each condition, there is a statistically significant difference between the mean scores of students who did not receive
reinforcers (Condition A) and students who earned reinforcers for correct responding (Condition B). The results of the simple effects for the conditions at each type of student indicate that, for both students with behavioral disorders and students with attention deficit disorders, there are significant differences in the mean math scores for each of the contingency conditions.

To determine which pairs or combination of means differ, a post hoc procedure for complex comparisons, the Scheffe' method, was applied to the data. According to Hinkle et al. (1988), the Scheffe' method is the most conservative, but also the most versatile, post hoc multiple comparison procedure, and it is recommended for complex contrasts. Results of the Scheffe' multiple comparison test are presented in Table 4.
Table 4

Scheffe's Multiple Comparison Test

<table>
<thead>
<tr>
<th>Comparison</th>
<th>F-Ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparisons for Students</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 with 2</td>
<td>6.8186</td>
<td>0.0015*</td>
</tr>
<tr>
<td>1 with 3</td>
<td>11.2921</td>
<td>0.0001*</td>
</tr>
<tr>
<td>2 with 3</td>
<td>0.5612</td>
<td>0.5719</td>
</tr>
<tr>
<td><strong>Comparisons for Conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 with 2</td>
<td>26.7406</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 with 3</td>
<td>15.1747</td>
<td>0.0001*</td>
</tr>
<tr>
<td>2 with 3</td>
<td>1.6273</td>
<td>0.2003</td>
</tr>
<tr>
<td><strong>Comparisons for Interactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 &amp; 1 with 1 &amp; 2</td>
<td>7.7307</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 1 with 1 &amp; 3</td>
<td>0.0159</td>
<td>0.9995</td>
</tr>
<tr>
<td>1 &amp; 1 with 2 &amp; 1</td>
<td>11.3310</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 1 with 2 &amp; 2</td>
<td>0.1214</td>
<td>0.9746</td>
</tr>
<tr>
<td>1 &amp; 1 with 2 &amp; 3</td>
<td>1.3208</td>
<td>0.2654</td>
</tr>
<tr>
<td>1 &amp; 1 with 3 &amp; 1</td>
<td>7.0851</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 1 with 3 &amp; 2</td>
<td>0.0401</td>
<td>0.9969</td>
</tr>
<tr>
<td>1 &amp; 1 with 3 &amp; 3</td>
<td>0.0924</td>
<td>0.9847</td>
</tr>
</tbody>
</table>

*(table continues)*
Table 4

**Scheffe' Multiple Comparison Test**

<table>
<thead>
<tr>
<th>Comparison</th>
<th>F-Ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &amp; 2 with 1 &amp; 3</td>
<td>8.4475</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 2 with 2 &amp; 1</td>
<td>37.7805</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 2 with 2 &amp; 2</td>
<td>5.9143</td>
<td>0.0002*</td>
</tr>
<tr>
<td>1 &amp; 2 with 2 &amp; 3</td>
<td>2.6607</td>
<td>0.0354**</td>
</tr>
<tr>
<td>1 &amp; 2 with 3 &amp; 1</td>
<td>29.6176</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 2 with 3 &amp; 2</td>
<td>8.8840</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 2 with 3 &amp; 3</td>
<td>9.5136</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 3 with 2 &amp; 1</td>
<td>10.4984</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 3 with 2 &amp; 2</td>
<td>0.2252</td>
<td>0.9239</td>
</tr>
<tr>
<td>1 &amp; 3 with 2 &amp; 3</td>
<td>1.6264</td>
<td>0.1712</td>
</tr>
<tr>
<td>1 &amp; 3 with 3 &amp; 1</td>
<td>6.4300</td>
<td>0.0001*</td>
</tr>
<tr>
<td>1 &amp; 3 with 3 &amp; 2</td>
<td>0.0055</td>
<td>0.9999</td>
</tr>
<tr>
<td>1 &amp; 3 with 3 &amp; 3</td>
<td>0.0317</td>
<td>0.9981</td>
</tr>
<tr>
<td>2 &amp; 1 with 2 &amp; 2</td>
<td>13.7986</td>
<td>0.0001*</td>
</tr>
<tr>
<td>2 &amp; 1 with 2 &amp; 3</td>
<td>20.3889</td>
<td>0.0001*</td>
</tr>
<tr>
<td>2 &amp; 1 with 3 &amp; 1</td>
<td>0.4961</td>
<td>0.7386</td>
</tr>
<tr>
<td>2 &amp; 1 with 3 &amp; 2</td>
<td>10.0234</td>
<td>0.0001*</td>
</tr>
<tr>
<td>2 &amp; 1 with 3 &amp; 3</td>
<td>9.3769</td>
<td>0.0001*</td>
</tr>
</tbody>
</table>

*The table continues*
Table 4

*Scheffe' Multiple Comparison Test*

<table>
<thead>
<tr>
<th>Comparison</th>
<th>F-Ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparisons for Interactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 &amp; 2 with 2 &amp; 3</td>
<td>0.6412</td>
<td>0.6340</td>
</tr>
<tr>
<td>2 &amp; 2 with 3 &amp; 1</td>
<td>9.0617</td>
<td>0.0001*</td>
</tr>
<tr>
<td>2 &amp; 2 with 3 &amp; 2</td>
<td>0.3010</td>
<td>0.8768</td>
</tr>
<tr>
<td>2 &amp; 2 with 3 &amp; 3</td>
<td>0.4257</td>
<td>0.7899</td>
</tr>
<tr>
<td>2 &amp; 3 with 3 &amp; 1</td>
<td>14.5239</td>
<td>0.0001*</td>
</tr>
<tr>
<td>2 &amp; 3 with 3 &amp; 2</td>
<td>1.8210</td>
<td>0.1284</td>
</tr>
<tr>
<td>2 &amp; 3 with 3 &amp; 3</td>
<td>2.1119</td>
<td>0.0827</td>
</tr>
<tr>
<td>3 &amp; 1 with 3 &amp; 2</td>
<td>6.0595</td>
<td>0.0002*</td>
</tr>
<tr>
<td>3 &amp; 1 with 3 &amp; 3</td>
<td>5.5592</td>
<td>0.0004*</td>
</tr>
<tr>
<td>3 &amp; 2 with 3 &amp; 3</td>
<td>0.0108</td>
<td>0.9998</td>
</tr>
</tbody>
</table>

* *p < .01. **p < .05.

Examination of the comparisons for students in Table 4 reveals the presence of significant differences in math performance between students with behavioral disorders and students with attention deficit disorders (1 with 2) and between students with behavioral disorders and students without disabilities (1 with 3). Significant differences in math performance were not found between students with attention deficit disorders and students without
disabilities (2 with 3). Therefore, Hypothesis 1, "There is a significant difference in math performance between students with behavioral disorders, students with attention deficit disorders, and students without disabilities across different contingency conditions," is retained for students with behavioral disorders and rejected for students with attention deficit disorders and students without disabilities.

Examination of the comparisons for conditions in Table 4 reveals the presence of significant differences in math performance when teacher-directed instruction is accompanied by no contingencies and when teacher-directed instruction is accompanied by contingencies for academic performance (1 with 2) or by contingencies for on-task behavior and academic performance (1 with 3). Significant differences were not found between the two conditions in which contingencies were provided (2 with 3). Therefore, Hypothesis 2, "There is a significant difference in student math performance when teacher-directed instruction is accompanied by no contingencies, contingencies for academic performance alone, or contingencies for on-task behavior and academic performance", is retained when teacher-directed instruction with no contingencies is compared to teacher-directed instruction with contingencies for academic performance alone or contingencies for on-task behavior and academic performance.
Overall, the subjects in Condition A solved more problems correctly than did the subjects in Conditions B and C. This difference in math performance could be explained in several ways. The students in Condition A were slightly older than the students in Conditions B and C; their average age was 6 months older than the average age of the other two experimental groups. Also, more of the students in the Condition A group knew how to solve the types of problems being posed on the introductory worksheet ($X = 0.42$) than did the students in either the Condition B group ($X = 0.03$) or the Condition C group ($X = 0.05$). Finally, the students in Conditions B and C may have been distracted from their work when the poker chips were placed on their desks. The researcher noted that some of the students would hold their poker chips in one hand while writing on the worksheets with the other hand.

Examination of the comparisons for interactions in Table 4 reveals a number of significant differences. The students with behavioral disorders in Condition A solved significantly fewer problems correctly than did the students with attention deficit disorders and the students without disabilities under the no contingencies condition. The students with behavioral disorders in Condition B solved significantly fewer problems correctly than any other group. The students with behavioral disorders in Condition C, on the other hand, did not demonstrate significant differences
in math performance from the students with attention deficit disorders and the students without disabilities who also received contingencies for on-task behavior and academic performance.

Discussion

The results of this study both confirmed and refuted the researcher's hypotheses. Overall, students with behavioral disorders solved significantly fewer problems correctly than did students with attention deficit disorders and students without disabilities. Only when students with behavioral disorders received reinforcers for both academic performance and on-task behavior did they perform equally as well as their peers with attention deficit disorders and their peers without disabilities. No significant difference in math performance was observed between students with attention deficit disorders and students without disabilities.

Significant differences in students' math performance were revealed when comparing teacher-directed instruction with no contingencies to teacher-directed instruction accompanied by contingencies for academic performance or accompanied by contingencies for both on-task behavior and academic performance. In this study, subjects who did not earn reinforcers (Condition A) solved more problems correctly overall than did the subjects who received reinforcers (Conditions B and C). This difference could be
attributed to (a) more students in Condition A having a preexisting knowledge of exponential notation, (b) a slightly higher average age in the Condition A group, or (c) distraction to the students in Conditions B and C caused by receiving reinforcers while they were working.
CHAPTER V

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

The purpose of this research study was to investigate the effects of supplemental on-task and performance contingencies on the acquisition of math skills for elementary school children (ages 8-11) identified as emotionally disturbed/behaviorally disordered, attention deficit disordered, and students without disabilities. Three experimental conditions were utilized, involving (a) teacher-directed instruction and independent seatwork with no contingencies provided for on-task behavior or academic performance, (b) teacher-directed instruction and independent seatwork with contingencies provided for academic performance only, and (c) teacher-directed instruction and independent seatwork with contingencies provided for academic performance and on-task behavior. This study was designed to measure the effects of these three learning conditions (i.e., no contingencies, performance contingencies, and on-task and performance contingencies) on the number of math problems solved correctly by students with behavioral disorders, students with attention deficit disorders, and students without
disabilities. This chapter provides a summary of the results of this study, implications for service provision, and recommendations for future research.

Results of the Study

Based on a review of the literature, two hypotheses were developed. First, it was hypothesized that there is a significant difference in math performance between students with behavioral disorders, students with attention deficit disorders, and students without disabilities across the three contingency conditions. The second hypothesis stated that there is a significant difference in student math performance when teacher-directed instruction is accompanied by no contingencies, contingencies for academic performance alone, or contingencies for on-task behavior and academic behavior.

Forty elementary public school children (ages 8-11) from three elementary school campuses participated in this study. Thirteen of these students had been diagnosed emotionally disturbed, 13 were medically diagnosed as having attention deficit disorders, and 14 had never been identified as in need of special education or as having attention deficit disorders. The subjects in this study were matched on age, grade placement, gender, ethnicity, and intellectual functioning.

All participants attended one introductory session and four experimental sessions. During the experimental
sessions, 8 minutes of teacher-directed instruction were provided on exponential notation skills. Then, for 8 minutes, subjects solved exponential notation problems on worksheets (See Appendix C). No contingencies were provided to students in Condition A. Contingencies were provided to students in Condition B for solving problems correctly. Contingencies were provided to students in Condition C for on-task behavior and for solving problems correctly. The number of problems solved correctly (i.e., raw scores) was calculated and recorded for each subject for each experimental session.

A two-way ANOVA revealed significant row and column main effects and significant interaction. In this study, subjects with behavioral disorders solved significantly fewer problems correctly than did subjects with attention deficit disorders and subjects without disabilities. However, when students with behavioral disorders earned reinforcers for on-task behavior and academic performance (Condition C), their math performance equaled that of their peers with attention deficit disorders and their peers without disabilities. No significant differences in math performance were observed between subjects with attention deficit disorders and subjects without disabilities.

When comparing teacher-directed instruction with no contingencies to teacher-directed instruction accompanied by contingencies for academic performance or accompanied by
contingencies for both on-task behavior and academic performance, significant differences in students' math performance were revealed. In this study, subjects who did not receive contingencies (Condition A) solved more problems correctly overall than did the subjects who received contingencies (Conditions B and C). Students in Condition A had a slightly higher average age that the students in Conditions B and C, and more subjects in Condition A had a preexisting knowledge of exponential notation than did the subjects in Conditions B and C. Also, some subjects in Conditions B and C may have been distracted by receiving tokens while they were working. Significant differences in math performance were not found between the subjects in Conditions B and C, except for students with behavioral disorders, who solved significantly more problems correctly when reinforced for both on-task behavior and academic performance (Condition C) than the students with behavioral disorders in Conditions A or B.

Implications

The findings of this study suggest that certain instructional modifications are necessary for students with behavioral disorders to perform equally as well as their peers in at least one academic area (i.e., mathematics). Because the students with behavioral disorders in this study solved significantly fewer math problems correctly within 8 minutes than the students with attention deficit disorders
and the students without disabilities, either (a) more time may be required for students with behavioral disorders to complete their work or (b) shortened assignments may be necessary. A third instructional strategy supported by this research and other studies (Rosenberg et al., 1985) is to provide students with behavioral disorders with reinforcement contingencies for both on-task behavior and academic performance, particularly when they are acquiring new skills. These instructional modifications can be implemented in, and are appropriate for, both general and special education classrooms.

No significant difference in math performance was found between students with attention deficit disorders and students without disabilities. These students, given teacher-directed instruction, performed similarly under the three contingency conditions. Based upon math performance alone, no distinction could be made between the subjects in this study who were medically diagnosed as attention deficit disordered and those subjects without disabilities.

In this study, subjects who did not receive reinforcers (Condition A) solved significantly more problems correctly than the subjects who earned contingent reinforcers (Conditions B and C). This finding is incompatible with other research (Aaron & Bostow, 1978; Ayllon & Roberts, 1974; Hay et al., 1977; Kirby & Shields, 1972; Rosenberg et al., 1985; Winett & Winkler, 1972). This difference could
be attributed to characteristics of the subjects in Condition A (i.e., subjects were older and had more background in exponential notation than subjects in Conditions B and C). This difference could also be attributed to the distraction caused by providing reinforcers to the students in Conditions B and C as they worked. This finding suggests that, when providing reinforcers to students, care should be taken to minimize distractions while the students are working.

Recommendations for Future Research

This study adds to the limited research available on strategies for increasing the math performance of students with behavioral disorders, but more research is needed examining both how to improve instruction for students with behavioral disorders and how to motivate these students to learn (Ruhl & Berlinghoff, 1992). This research is needed in all subject areas, across subjects, grade levels, and interventions (Ruhl & Berlinghoff, 1992).

Two recommendations are offered for extending the current study. First, a replication of this study which utilizes more than four experimental sessions is advocated and may yield different results. Once the novelty of the task diminishes, it is possible that students receiving no reinforcers would begin solving fewer and fewer problems correctly while the students who earn reinforcers would maintain their rate of correct responding. Secondly,
replicating this study and videotaping the experimental sessions is recommended. Adding this qualitative component may broaden the interpretation of the quantitative results.
WORKSHEET FOR INTRODUCTORY SESSION

DIRECTIONS: Circle either Base or Exponent.

\[
7^4 \quad 4 = \text{Base or Exponent} \\
1^3 \quad 1 = \text{Base or Exponent} \\
5^6 \quad 5 = \text{Base or Exponent}
\]

DIRECTIONS: Expand the following:

\[
6^2 = \\
3^5 = \\
2^7 =
\]

DIRECTIONS: Write the correct base and exponent.

\[
9 \times 9 \times 9 \times 9 = \\
4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 = \\
7 \times 7 \times 7 =
\]

DIRECTIONS: Write the correct base and exponent.

\[
1^5 \times 1^0 = \\
5^3 \times 5^4 = \\
8^6 \times 8^1 =
\]
APPENDIX B

REINFORCER MENU
REINFORCER MENU

DIRECTIONS: Put a "1" in front of the item you like the most, a "2" in front of your second favorite item, etc. There are 14 items in all, so be sure you number all the items.

___ Colorful pencils
___ Erasers
___ Notepads
___ Folders
___ Pens
___ Stickers (one page)
___ Baseball cards
___ Football cards
___ Super balls
___ Hot Wheels cars
___ Crayon cars
___ Peanuts
___ Fruit snacks
___ Popcorn
APPENDIX C

WORKSHEETS FOR EXPERIMENTAL SESSIONS
WORKSHEET FOR EXPERIMENTAL SESSION 1

DIRECTIONS: Circle either Base or Exponent.

5 \textsuperscript{1} 5 = \text{Base or Exponent}

2 \textsuperscript{3} 2 = \text{Base or Exponent}

6 \textsuperscript{2} 2 = \text{Base or Exponent}

4 \textsuperscript{0} 0 = \text{Base or Exponent}

3 \textsuperscript{4} 4 = \text{Base or Exponent}

7 \textsuperscript{3} 7 = \text{Base or Exponent}

2 \textsuperscript{5} 5 = \text{Base or Exponent}

3 \textsuperscript{0} 3 = \text{Base or Exponent}

4 \textsuperscript{2} 2 = \text{Base or Exponent}

1 \textsuperscript{3} 1 = \text{Base or Exponent}

5 \textsuperscript{1} 1 = \text{Base or Exponent}

8 \textsuperscript{4} 4 = \text{Base or Exponent}

6 \textsuperscript{2} 6 = \text{Base or Exponent}

3 \textsuperscript{5} 5 = \text{Base or Exponent}

2 \textsuperscript{0} 0 = \text{Base or Exponent}

1 \textsuperscript{6} 1 = \text{Base or Exponent}

7 \textsuperscript{3} 3 = \text{Base or Exponent}

5 \textsuperscript{2} 5 = \text{Base or Exponent}

6 \textsuperscript{1} 1 = \text{Base or Exponent}

9 \textsuperscript{4} 4 = \text{Base or Exponent}
WORKSHEET FOR EXPERIMENTAL SESSION 1

DIRECTIONS: Circle either Base or Exponent.

4 \(^1\) 4 = Base or Exponent

2 \(^7\) 7 = Base or Exponent

5 \(^3\) 3 = Base or Exponent

9 \(^2\) 9 = Base or Exponent

6 \(^4\) 4 = Base or Exponent

1 \(^5\) 5 = Base or Exponent

3 \(^1\) 3 = Base or Exponent

4 \(^9\) 9 = Base or Exponent

8 \(^0\) 0 = Base or Exponent

6 \(^5\) 6 = Base or Exponent

5 \(^4\) 5 = Base or Exponent

2 \(^6\) 6 = Base or Exponent

7 \(^2\) 2 = Base or Exponent

9 \(^3\) 9 = Base or Exponent

8 \(^9\) 9 = Base or Exponent

1 \(^0\) 1 = Base or Exponent

4 \(^0\) 0 = Base or Exponent

3 \(^5\) 5 = Base or Exponent

5 \(^7\) 5 = Base or Exponent

6 \(^1\) 1 = Base or Exponent
WORKSHEET FOR EXPERIMENTAL SESSION 1

DIRECTIONS: Circle either Base or Exponent.

3^2 2 = Base or Exponent
9^0 9 = Base or Exponent
3^7 7 = Base or Exponent
6^0 0 = Base or Exponent
3^1 1 = Base or Exponent
4^8 4 = Base or Exponent
5^3 5 = Base or Exponent
6^1 1 = Base or Exponent
2^5 5 = Base or Exponent
4^9 4 = Base or Exponent
1^5 1 = Base or Exponent
2^6 2 = Base or Exponent
8^2 2 = Base or Exponent
5^2 5 = Base or Exponent
2^4 2 = Base or Exponent
3^9 9 = Base or Exponent
7^3 3 = Base or Exponent
4^0 4 = Base or Exponent
9^8 8 = Base or Exponent
6^1 6 = Base or Exponent
WORKSHEET FOR EXPERIMENTAL SESSION 1

DIRECTIONS: Expand the following:

\[ \begin{align*}
8^3 &= \\
4^2 &= \\
9^1 &= \\
1^4 &= \\
7^0 &= \\
5^5 &= \\
4^3 &= \\
9^6 &= \\
5^1 &= \\
8^4 &= \\
2^3 &= \\
4^0 &= \\
1^2 &= \\
7^5 &= \\
3^4 &= \\
6^6 &= \\
9^3 &= \\
5^2 &= \\
8^1 &= \\
2^4 &= 
\end{align*} \]
WORKSHEET FOR EXPERIMENTAL SESSION 1

DIRECTIONS: Expand the following:

3 2 =
9 1 =
3 7 =
6 0 =
8 4 =
4 6 =
5 3 =
6 1 =
2 5 =
4 9 =
1 5 =
2 6 =
8 2 =
5 2 =
3 4 =
7 3 =
5 9 =
9 8 =
6 5 =
4 3 =
WORKSHEET FOR EXPERIMENTAL SESSION 1

DIRECTIONS: Expand the following:

\[ 4^1 = \]
\[ 2^7 = \]
\[ 5^3 = \]
\[ 9^2 = \]
\[ 6^4 = \]
\[ 1^5 = \]
\[ 3^1 = \]
\[ 4^9 = \]
\[ 8^0 = \]
\[ 6^5 = \]
\[ 5^4 = \]
\[ 2^6 = \]
\[ 7^2 = \]
\[ 9^3 = \]
\[ 8^9 = \]
\[ 1^0 = \]
\[ 4^4 = \]
\[ 3^5 = \]
\[ 5^7 = \]
\[ 6^1 = \]
WORKSHEET FOR EXPERIMENTAL SESSION 2

DIRECTIONS: Write the correct base and exponent.

\[
\begin{align*}
7 \times 7 &= \\
3 \times 3 \times 3 \times 3 &= \\
1 \times 1 \times 1 &= \\
5 \times 5 \times 5 \times 5 &= \\
8 \times 8 \times 8 &= \\
6 \times 6 &= \\
4 \times 4 &= \\
2 \times 2 \times 2 &= \\
9 \times 9 \times 9 &= \\
8 \times 8 &= \\
7 \times 7 \times 7 &= \\
5 \times 5 &= \\
1 \times 1 &= \\
3 \times 3 \times 3 &= \\
6 \times 6 &= \\
2 \times 2 &= \\
4 \times 4 &= \\
9 \times 9 &= \\
8 \times 8 &= \\
6 \times 6 &= \\
\end{align*}
\]
WORKSHEET FOR EXPERIMENTAL SESSION 2

DIRECTIONS: Write the correct base and exponent.

3 \times 3 \times 3 =

9 \times 9 \times 9 \times 9 \times 9 =

4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 =

6 \times 6 \times 6 =

8 \times 8 \times 8 \times 8 =

7 \times 7 \times 7 \times 7 \times 7 \times 7 =

5 \times 5 =

2 \times 2 \times 2 \times 2 \times 2 =

3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 =

1 \times 1 \times 1 \times 1 \times 1 =

2 \times 2 \times 2 \times 2 \times 2 \times 2 =

8 \times 8 =

5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 =

3 \times 3 \times 3 \times 3 =

7 \times 7 \times 7 =

4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 =

9 \times 9 \times 9 \times 9 \times 9 \times 9 \times 9 \times 9 =

6 \times 6 \times 6 \times 6 \times 6 =

4 \times 4 \times 4 =

2 \times 2 \times 2 \times 2 \times 2 =
WORKSHEET FOR EXPERIMENTAL SESSION 2

DIRECTIONS: Write the correct base and exponent.

\[4 \times 4 \times 4 \times 4 \times 4 \times 4 = \]
\[2 \times 2 \times 2 \times 2 \times 2 \times 2 = \]
\[5 \times 5 \times 5 = \]
\[9 \times 9 = \]
\[6 \times 6 \times 6 \times 6 = \]
\[1 \times 1 \times 1 \times 1 \times 1 = \]
\[3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 = \]
\[4 \times 4 \times 4 \times 4 = \]
\[8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 = \]
\[6 \times 6 \times 6 \times 6 \times 6 = \]
\[5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 = \]
\[2 \times 2 \times 2 \times 2 \times 2 \times 2 = \]
\[7 \times 7 = \]
\[9 \times 9 \times 9 = \]
\[8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 = \]
\[1 \times 1 \times 1 \times 1 = \]
\[4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 = \]
\[3 \times 3 \times 3 \times 3 \times 3 = \]
\[5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 = \]
\[6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6 = \]
WORKSHEET FOR EXPERIMENTAL SESSION 2

DIRECTIONS: Write the correct base and exponent.

\[ 6^3 \times 6^2 = \]
\[ 4^1 \times 4^6 = \]
\[ 2^2 \times 2^1 = \]
\[ 5^3 \times 5^3 = \]
\[ 1^4 \times 1^5 = \]
\[ 3^5 \times 3^2 = \]
\[ 9^1 \times 9^1 = \]
\[ 7^2 \times 7^4 = \]
\[ 4^3 \times 4^5 = \]
\[ 8^6 \times 8^3 = \]
\[ 2^2 \times 2^5 = \]
\[ 1^5 \times 1^1 = \]
\[ 6^4 \times 6^2 = \]
\[ 5^3 \times 5^4 = \]
\[ 9^2 \times 9^6 = \]
\[ 4^1 \times 4^3 = \]
\[ 3^4 \times 3^5 = \]
\[ 7^5 \times 7^1 = \]
\[ 8^3 \times 8^4 = \]
\[ 5^6 \times 5^5 = \]
WORKSHEET FOR EXPERIMENTAL SESSION 2

DIRECTIONS: Write the correct base and exponent.

\[ 6^2 \times 6^4 = \]
\[ 4^3 \times 4^5 = \]
\[ 2^5 \times 2^4 = \]
\[ 5^1 \times 5^2 = \]
\[ 1^6 \times 1^3 = \]
\[ 3^4 \times 3^3 = \]
\[ 9^1 \times 9^7 = \]
\[ 7^7 \times 7^1 = \]
\[ 4^2 \times 4^5 = \]
\[ 8^9 \times 8^0 = \]
\[ 2^3 \times 2^2 = \]
\[ 1^5 \times 1^5 = \]
\[ 6^1 \times 6^4 = \]
\[ 5^4 \times 5^3 = \]
\[ 9^0 \times 9^1 = \]
\[ 4^6 \times 4^2 = \]
\[ 3^2 \times 3^8 = \]
\[ 7^8 \times 7^1 = \]
\[ 8^5 \times 8^4 = \]
\[ 5^7 \times 5^0 = \]
WORKSHEET FOR EXPERIMENTAL SESSION 2

DIRECTIONS: Write the correct base and exponent.

\[ 2^4 \times 2^5 = \]
\[ 4^1 \times 4^3 = \]
\[ 6^4 \times 6^2 = \]
\[ 8^4 \times 8^6 = \]
\[ 3^2 \times 3^4 = \]
\[ 5^2 \times 5^6 = \]
\[ 7^1 \times 7^6 = \]
\[ 7^4 \times 7^2 = \]
\[ 1^3 \times 1^1 = \]
\[ 8^2 \times 8^7 = \]
\[ 6^1 \times 6^3 = \]
\[ 2^6 \times 2^5 = \]
\[ 5^2 \times 5^0 = \]
\[ 8^5 \times 8^3 = \]
\[ 5^4 \times 5^4 = \]
\[ 2^1 \times 2^8 = \]
\[ 9^3 \times 9^2 = \]
\[ 1^2 \times 1^4 = \]
\[ 5^5 \times 5^5 = \]
\[ 2^6 \times 2^3 = \]
WORKSHEET FOR EXPERIMENTAL SESSION 3

DIRECTIONS: Solve the following.

9^4 = Base or Exponent

6^6 =

9^3 =

1^3 = Base or Exponent

5^1 = Base or Exponent

2^3 =

4^0 =

2 x 2 x 2 =

8 x 8 x 8 x 8 x 8 =

1 x 1 =

1^2 =

7^5 =

8^4 x 8^2 =

5^6 x 5^3 =

6^1 x 6^1 =

4^2 = Base or Exponent

7^1 = Base or Exponent

8 x 8 =

7 x 7 x 7 x 7 =

3^4 =
WORKSHEET FOR EXPERIMENTAL SESSION 3

DIRECTIONS: Solve the following.

$7^3 \quad 7 = \text{Base or Exponent}$

$2^5 \quad 5 = \text{Base or Exponent}$

$3 \times 3 \times 3 \times 3 \times 3 =$

$6 \times 6 \times 6 \times 6 =$

$2 \times 2 =$

$4 \times 4 \times 4 \times 4 \times 4 =$

$3^4 \times 3^5 =$

$7^5 \times 7^1 =$

$2^3 \times 2^2 =$

$6 \times 6 =$

$4 \times 4 \times 4 =$

$2 \times 2 \times 2 \times 2 =$

$9 \times 9 \times 9 \times 9 \times 9 =$

$1^2 \times 1^5 =$

$4^1 \times 4^3 =$

$3^0 \quad 3 = \text{Base or Exponent}$

$4^2 \quad 2 = \text{Base or Exponent}$

$1 \times 1 \times 1 =$

$4^8 =$

$9^3 =$
WORKSHEET FOR EXPERIMENTAL SESSION 3

DIRECTIONS: Solve the following.

\[ 2^5 = \]
\[ 5^8 = \]
\[ 1^3 = \]
\[ 8^4 = \]
\[ 3 \times 3 \times 3 \times 3 \times 3 = \]
\[ 7 \times 7 = \]
\[ 9 \times 9 \times 9 \times 9 \times 9 \times 9 \times 9 = \]
\[ 6 \times 6 \times 6 = \]
\[ 5^6 = \text{Base or Exponent} \]
\[ 4^1 = \text{Base or Exponent} \]
\[ 9^0 = \text{Base or Exponent} \]
\[ 6^3 = \text{Base or Exponent} \]
\[ 1^5 \times 1^4 = \]
\[ 7^6 \times 7^1 = \]
\[ 2^3 \times 2^6 = \]
\[ 5^0 \times 5^2 = \]
\[ 8^4 \times 8^5 = \]
\[ 5^1 = \text{Base or Exponent} \]
\[ 2^9 = \text{Base or Exponent} \]
\[ 3 \times 3 \times 3 \times 3 = \]
WORKSHEET FOR EXPERIMENTAL SESSION 3

DIRECTIONS: Write the correct base and exponent.

$9^0 \times 9^3 =$

$1^6 \times 1^2 =$

$5^7 \times 5^1 =$

$3^8 \times 3^2 =$

$4^5 \times 4^5 =$

$7^3 =$

$8^9 =$

$1^2 =$

$5^6 =$

$2^7 =$

$6 \times 6 \times 6 \times 6 \times 6 =$

$9 \times 9 \times 9 =$

$1 \times 1 \times 1 \times 1 \times 1 \times 1 \times 1 =$

$3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 =$

$7^7 =$

$8^9 \quad \text{Base or Exponent}$

$2^6 \quad \text{Base or Exponent}$

$6^0 \quad \text{Base or Exponent}$

$9^2 \quad \text{Base or Exponent}$

$3^1 \quad \text{Base or Exponent}$
WORKSHEET FOR EXPERIMENTAL SESSION 4

DIRECTIONS: Solve the following.

\[ 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 = \]

\[ 6 \times 6 \times 6 = \]

\[ 9 \times 9 \times 9 \times 9 \times 9 = \]

\[ 1 \times 1 = \]

\[ 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 = \]

\[ 8^0 \quad 8 = \text{Base or Exponent} \]

\[ 3^1 \quad 1 = \text{Base or Exponent} \]

\[ 7^2 \quad 2 = \text{Base or Exponent} \]

\[ 4^9 \quad 4 = \text{Base or Exponent} \]

\[ 2^7 \quad 7 = \text{Base or Exponent} \]

\[ 6^6 = \]

\[ 5^1 = \]

\[ 8^4 = \]

\[ 3^5 = \]

\[ 1^9 = \]

\[ 5^4 \times 5^3 = \]

\[ 8^3 \times 8^6 = \]

\[ 1^1 \times 1^7 = \]

\[ 2^8 \times 2^2 = \]

\[ 7^5 \times 7^4 = \]
WORKSHEET FOR EXPERIMENTAL SESSION 4

DIRECTIONS: Solve the following.

9^2 \times 9^3 =

5^4 \times 5^0 =

4^2 \times 4^6 =

1^3 \times 1^5 =

7^6 \times 7^1 =

2 \times 2 \times 2 \times 2 \times 2 \times 2 =

6 \times 6 \times 6 \times 6 =

8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 =

3 \times 3 =

5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 =

3^5 \quad 3 = \text{Base or Exponent}

9^4 \quad 4 = \text{Base or Exponent}

1^8 \quad 8 = \text{Base or Exponent}

6^2 \quad 6 = \text{Base or Exponent}

7^9 \quad 7 = \text{Base or Exponent}

4^0 =

9^6 =

2^9 =

7^2 =

1^7 =
WORKSHEET FOR EXPERIMENTAL SESSION 4

DIRECTIONS: Solve the following.

6^1 = Base or Exponent
8^6 = Base or Exponent
3^0 = Base or Exponent
9^2 = Base or Exponent
5^4 = Base or Exponent

1^5 =
4^3 =
7^9 =
6^0 =

2^6 =
3 \times 3 \times 3 \times 3 \times 3 \times 3 =
5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 =
1 \times 1 \times 1 =
8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 =
9 \times 9 \times 9 \times 9 =
5^5 \times 5^5 =
8^2 \times 8^7 =
4^1 \times 4^3 =
2^8 \times 2^1 =
3^4 \times 3^2 =
WORKSHEET FOR EXPERIMENTAL SESSION 4

DIRECTIONS: Solve the following.

\[ 6^1 \times 6^4 = \]
\[ 2^3 \times 2^2 = \]
\[ 5^0 \times 5^9 = \]
\[ 9^3 \times 9^5 = \]
\[ 3^7 \times 3^1 = \]
\[ 8^9 \quad 8 = \text{Base or Exponent} \]
\[ 5^2 \quad 2 = \text{Base or Exponent} \]
\[ 1^5 \quad 5 = \text{Base or Exponent} \]
\[ 4^7 \quad 4 = \text{Base or Exponent} \]
\[ 6^3 \quad 3 = \text{Base or Exponent} \]
\[ 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = \]
\[ 3 \times 3 = \]
\[ 9 \times 9 \times 9 \times 9 \times 9 \times 9 = \]
\[ 6 \times 6 \times 6 \times 6 \times 6 = \]
\[ 4 \times 4 \times 4 = \]
\[ 9^4 = \]
\[ 8^8 = \]
\[ 2^0 = \]
\[ 7^6 = \]
\[ 3^1 = \]
REFERENCES


Attention Deficit Hyperactivity Disorder Advisory Committee. (1991). Report to the 72nd legislature: Guidelines for school districts for identifying and testing children with attention deficit hyperactivity disorder and a proposed program for providing appropriate services. Austin, TX: Texas Education Agency.


