

# The Effectiveness of Touch Math on Improving Early Mathematics Ability of Kindergarten Children with Mild to Borderline Intellectual Functioning in an Inclusion Classroom

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**Abstract.** Touchmath®, also known as Touchpoint, is a multi-sensory method that involves visual, auditory, and tactile learning, and it can be used effectively with children with disabilities. It has successfully solved addition and subtraction problems with a single digit and two digits, specifically for children with disabilities. Six children participated. A multiple baseline design was used. The Test of Early Mathematics Ability was employed. The findings revealed that the touch math training program effectively improved the Early Mathematics Ability of each participant. All six children were found to be successful at the end of the teaching session compared to the baseline. The finding that Touchmath® showed positive effects based on a direct teaching approach in improving the Early Mathematics Ability of kindergarten children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom is effective, sustainable, generalizable, and socially valid in teaching basic addition skills to students with mild intellectual disabilities in general education classrooms, conforms to other research conclusions in the literature.

**Keywords:** Touchmath® program, Early Mathematics Ability, kindergarten children with mild to borderline intellectual functioning, typically developing peers, inclusion classroom.

## INTRODUCTION

Intellectual disability (intellectual developmental disorder) is a disorder with onset during the developmental period that includes both intellectual and adaptive functioning deficits in conceptual, social, and practical domains. Deficits in intellectual functions, such as reasoning, problem-solving, planning, abstract thinking, judgment, academic learning, and learning from experience, are confirmed by both clinical assessment and individualized, standardized intelligence testing [1-5]. The various levels of severity are defined based on adaptive functioning [6-11].

Research shows that the mathematical development of children with Intellectual disability is to some degree similar to that of normal or without Intellectual disability children but may be described as delayed and slower [12-14]. It is generally agreed that Early Mathematics Ability is critical in the daily lives of children with Intellectual disabilities [13]. Problems with reading fluency and comprehension, spelling, written expression, and numeracy skills in everyday life typically persist into adulthood [4]. Sermier Dessemontet *et al.* [15] showed that children with Intellectual disabilities included in regular classrooms made slightly more progress in literacy skills than children attending special schools. However, no

difference between the groups was found in mathematics. These results demonstrate the paucity of research on the mathematical development of students in inclusive classrooms.

Furthermore, only the study by Peetsma *et al.* [16] found significant long-term effects on mathematical attainment after 4 years. Schnepel *et al.* [13] conducted an intervention study in inclusive classrooms with students with ID. The experimental group received a program to foster basic numerical competencies, while the control group carried out a program designed to support social participation. No effect from the mathematical intervention could be found. Specifically, Jordan *et al.* [17] report that number sense performance in kindergarten accounted for 66% of first graders' arithmetic achievement variance.

The research regarding the implementation of the Touchmath® Program suggests that this program may be considered a reliable intervention for children with mental disabilities [8, 18], students with the most significant cognitive disabilities [19], Autism [20], and typically developing young children [21].

## Touchmath® in Children with Disabilities

Children with disabilities may not be successful in learning mathematical skills because of ineffective teaching, verbal language problems, cognitive factors, low reading skills, affective factors, inadequate visual perception, inattention, and inadequate motor skills

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[22]. In order to make effective teaching for these students, teachers should use the most effective and efficient ways of developing and implementing mathematics programs. Touch math technique is a teaching technique that is used to teach mathematical skills, especially for students with special needs [23]. Touchmath®, also known as Touchpoint, is a multi-sensory method that involves visual, auditory, and tactile learning [21], and it can be used effectively with children with disabilities [24]. It has been proven successful in solving addition and subtraction problems with single-digit [9] and two digits [25], specifically for children with disabilities [26]. Nelson [27] confirmed what previous studies on Touchmath® had shown that students made significant gains in the area of mathematical accuracy with single-digit addition.

Bullock [28] began using this approach with her struggling students. She placed counting points on numbers. To her surprise, she notices immediate results with her students; they were beginning to make the transition from concrete to symbolic learning. Using Touchmath® with three elementary students with mild disabilities, Scott [29] found that students were able to maintain their knowledge and were able to generalize their knowledge to other mathematical situations. Pupo [30] investigated the utility of Touchmath® with three students with intellectual disabilities. After the teaching of Touchmath®, they could solve addition problems correctly.

As the effectiveness of Touchmath® as a multi-sensory approach to improve Early Mathematics Ability of kindergarten children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom is very limited. The present study contributes to the literature about Touchmath® by gathering data from a multiple baseline design on the effectiveness of Touchmath® with mild to borderline intellectual functioning and their typically developing peers.

In line with the purpose of this study, we seek to give answers to the following questions:

- (a) Is the Touchmath® technique effective in teaching basic mathematical skills (e.g., counting, calculation, number comparison, numeral writing, and recognition) to children with mild to borderline intellectual functioning and their typically developing peers?
- (b) Is the effectiveness maintained for one month after the skills have been learned?

- (c) Can children with mild to borderline intellectual functioning and their typically developing peers generalize the skills they have learned to other settings?

## METHOD

### Participants

The children were expected to have certain prerequisite skills such as (a) the ability to follow instructions such as do, show, write, count, look at the sheet, examine the problem, and add. (b) fine motor skills, (c) the ability to recognize numbers between 1 and 10, (d) the ability to count rhythmically up to 10, (e) the ability to direct attention to the activity for 10 minutes. All children were right-handed.

During the selection of those who would participate, targeted children were also observed separately during Mathematical classes to determine their actual mathematical performance. At the end of the observation period, each child was met in an adjunct room and asked to count from 1 to 10, say the numbers 1 to 10, and write that number on his notebook. Six children were chosen to be involved in the study, three with mild to borderline intellectual functioning, and three were typically developing peers. Prior to the study, the parents of the participants were provided with information about it, and the parents signed written consent. Pseudonyms were used for the participants involved in the study.

Case1 is a 5-year-old female child diagnosed with mild to borderline intellectual functioning with no other disability. She is now in KG2. She received a mild to borderline intellectual functioning diagnosis by a speech specialist in the area in which she lives. Though Samar could count 1 to 10 verbally, she found it difficult in other skills(e. g. calculation, number comparison, numeral writing, and recognition). To some degree, she was able to follow instructions such as look, tell, and write.

The same thing can be said about case 2, who was 5.6 years old. He was diagnosed with mild to borderline intellectual functioning. He received a mild to borderline intellectual functioning diagnosis by a speech specialist in the area in which he lives. Though case 2 was able to verbally count 1 to 10, he had difficulties in other skills(e. g. calculation, number comparison, numeral writing, and recognition).To some degree, he was able to follow instructions such as look, tell, and write.

**Table 1: Demographic Features of the Participants**

Case	Sex	Age	Diagnosis
Case 1	F	5	ID
Case 2	M	5.6	ID
Case 3	M	5.3	ID
Case 4	F	5.2	typically developing
Case 5	M	5.1	typically developing
Case 6	F	5.7	typically developing

Case 3 was diagnosed with mild to borderline intellectual functioning. He received a mild to borderline intellectual functioning diagnosis by a speech specialist in the area in which he lives. He could verbally count 1 to 10, and he had difficulties in other skills (e. g. calculation, number comparison, numeral writing, and recognition). He was able to follow instructions such as look, tell, and write.

Three typically developing peers (Case 4, Case 5, and Case 6) were randomly selected. Case 4 was 5.2 years old. She was in KG2. She was able to follow instructions such as look, tell, and write. Case 5 was 5.1 years old. He was in KG2. He was able to follow instructions such as look, tell, and write. Case 6 was 5.7 years old. She was in KG2 in the same classroom. She was able to follow instructions such as look, tell, and write.

**MEASURES**

The Test of Early Mathematics Ability (particularly developed for this study)

It is a math assessment for children aged 5-6 years. It measures mathematical concepts (i.e., counting, calculation, number comparison, numeral writing, and recognition). Each has 5 mathematical problems. Each right answer was given one point, while the wrong one took zero. The composite score for the whole test was 25 scores. The Cronbach's alpha statistic was calculated to determine the internal consistency. It reported internal consistency of above 0.88 and took approximately 25 minutes to administer.

**PILOT STUDY**

The first researcher piloted all the activities with the two groups of children prior to the commencement of the research study. Materials, activities, and mathematical problems were adjusted for the current

study based on children's feedback and reaction to the activities. For example, the researcher increased the time spent on each mathematical problem for children with mild to borderline intellectual functioning as they need much time compared to their typically developing peers. Some planned activities in the pilot study proved to be too difficult for the children to understand, such as those of number comparison, the different methods of explanation, and much time we're given for those who found this exercise difficult.

**EXPERIMENTAL DESIGN**

A multiple baseline design was used to evaluate the effectiveness of a touch math training program on improving the Early Mathematics Ability of kindergarten children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom.

**RESULTS**

**Baseline & Intervention**

Prior to the teaching session, baseline data was collected for each child to determine the participants' performance levels. During baseline, the first author gave each child a strip of paper and a pencil. The participant was prompted with the instructional cue, "Write name." No direct feedback regarding the participant's performance was given. Specific praise was given for overall effort and responding to the task.

Case 1. During the baseline, Case 1 's scores at the whole ranged from 0-2 for the first four sessions. Samar was only able to solve two mathematical problems correctly at most in the baseline phase. When the intervention phase started, Case 1 's scores ranged from 10-15; that is, she was able to solve from ten to fifteen mathematical problems correctly, as shown in her daily Touchmath® worksheets.

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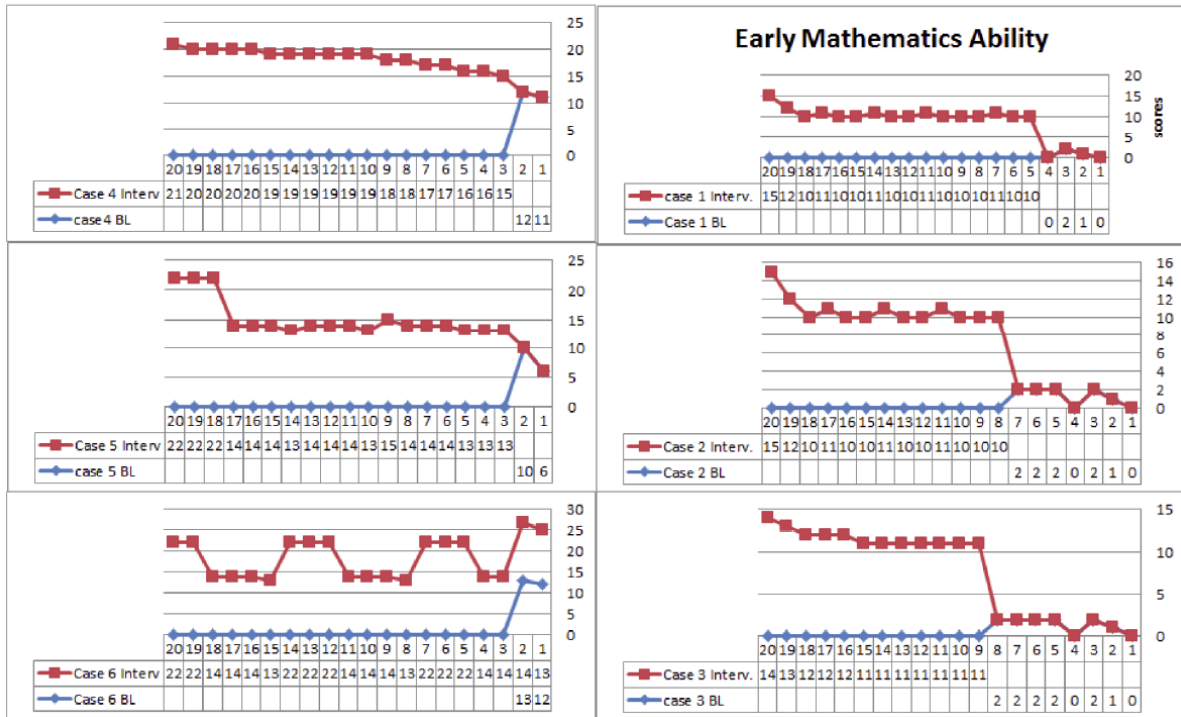


Figure 1: The baseline and intervention data for all children.

Case 2. During the baseline, Case 2 's scores at the whole ranged from 0-2 too for the first seven sessions. Case 2 was only able to solve two mathematical problems correctly at most in the baseline phase. When the intervention phase started, Case 2 's scores ranged from 10-15; that is, he was able to solve from ten to fifteen mathematical problems correctly, as shown in his daily Touchmath® worksheets.

Case 3. During the baseline, Case 3 's scores at the whole ranged from 0-2 too for the first eight sessions. Case 3 was able to solve two mathematical problems correctly at most in the baseline phase. When the intervention phase started, Case 3 's scores ranged from 11-14, i.e., he was able to solve from eleven to fourteen mathematical problems correctly, as shown in his daily Touchmath® worksheets.

Case 4. During the baseline, Case 4 's scores at the whole ranged from 11-12 for the first two sessions. The intervention phase started early for Case 4 as she was able to solve 11-12 mathematical problems correctly in the baseline phase. When the intervention phase started, Case 4 's scores ranged from 11-21, i.e., she was able to solve from eleven to twenty-one mathematical problems correctly, as shown in her daily Touchmath® worksheets.

Case 5. During the baseline, Case 5 's scores at the whole ranged from 6-10 for the first two sessions. The intervention phase started early for Case 5 as he was able to solve 6-10 mathematical problems correctly in the baseline phase. When the intervention phase started, Case 5 's scores ranged from 13-22, i.e., he was able to solve from thirteen to twenty-two mathematical problems correctly, as shown in his daily Touchmath® worksheets.

Case 6. During the baseline, Case 6 's scores at the whole ranged from 12-13 for the first two sessions. The intervention phase started early for Case 6 as he was able to solve 12-13 mathematical problems correctly in the baseline phase. When the intervention phase started, Case 6's scores ranged from 13-22, i.e., she was able to solve from thirteen to twenty-two mathematical problems correctly, as shown in her daily TouchMath worksheets.

**DISCUSSION AND CONCLUSION**

An intervention including Touchmath® showed positive effects in improving the Early Mathematics Ability of kindergarten children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom. Touchmath® is a multi-sensory approach used with basic computation

math skills. Children, in this approach, according to Saad & Hisham [9], manipulate and memorize math facts. Children in Touchmath® see, touch, say, and hear each digit. Samar, who was a child with mild to borderline intellectual functioning, was only able to solve two mathematical problems correctly at most in the baseline phase. However, once the intervention phase started, she could solve from ten to fifteen mathematical problems correctly, as shown in her daily Touchmath® worksheets. And so did the rest of other children with mild to borderline intellectual functioning and their typically developing peers. This finding goes in the same line with the findings of other research done on the teaching of basic addition skills in line with the Touch Math technique [20, 31-36].

In conclusion, the aim of this study was to provide further and additional information on the effectiveness of Touchmath® as a multi-sensory approach in improving the Early Mathematics Ability of kindergarten children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom. It suggested that Touchmath®, as a multi-sensory approach, effectively improved the Early Mathematics Ability of kindergarten children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom. This current study added to and expanded previous research on Touchmath® as a multi-sensory approach. In order to be able to master questions: (a) Is the touch math technique effective in teaching basic mathematical skills (e.g., counting, calculation, number comparison, numeral writing and recognition, children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom need direct instruction [20]. The finding that Touchmath® showed positive effects based on a direct teaching approach in improving the Early Mathematics Ability of kindergarten children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom is effective, sustainable, generalizable, and socially valid in teaching basic addition skills to students with mild intellectual disabilities in general education classrooms, conforms to other research conclusions in the literature.

### **IMPLICATIONS FOR PRACTICE**

Based upon the data from As shown in the data drawn from current Touchmath® literature, Touchmath® is likely to be an effective method to teach mathematics to young children. Accordingly,

teachers should consider the use of Touchmath® with children with mild to borderline intellectual functioning and their typically developing peers in an inclusion classroom in improving Early Mathematics Ability. There are some critical components of Touchmath® that will increase the success of the intervention if taught properly. They are using modeling how to count the points on each number, feedback when the number is counted incorrectly, clear, explicit instructions, guided practice through the use of the dots on the numbers, and specific praise for using the strategy. Reinforcement systems should also be used in conjunction with Touchmath®.

### **LIMITATIONS OF THIS STUDY**

Although the results showed that all children made significant gains in the area of Early Mathematics Ability, a number of limitations exist and should be addressed. First, the small sample size makes it difficult to generalize findings to other children. With the small sample, it is difficult to determine if the same results could be achieved with other children, particularly those who have the same disability. Secondly, the results from this study for children with mild to borderline intellectual functioning and their typically developing peers cannot be anticipated to generalize to children in other geographical areas or schools with different backgrounds. Third, this study was conducted on preschool children. Future research needs to look at older children. Future research should be conducted to validate the findings of this study with diverse populations, larger sample sizes, and other geographical locations.

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