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Effectiveness Of Sensorimotor Intervention To Improve The Handwriting Among Primary School Children With Handwriting Difficulties

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ABSTRACT: Handwriting is a major occupation for children in the classroom environment. Earlier studies found that 30% to 60% of a child's day at school was spent on fine motor activities, with 85% of these fine motor activities being paper-and-pencil tasks. Since handwriting is an occupation that consumes a substantial amount of time, children who struggle with it tend to have issues with various aspects of their learning and it requires a lot of time and effort for students to learn how to write clearly. The study aims to improve the handwriting of primary school children after receiving sensorimotor intervention in a classroom environment and evaluate their handwriting performance.

METHOD: A Quasi-experimental study was conducted in primary school children. After obtaining parent's consent, children in grade 2 (age=7-8, n=100) were screened using the Screener of Handwriting Proficiency. The collected data were analysed and results were recorded. The children with handwriting difficulties(n=35) were segregated according to the inclusion criteria and the selected children were given sensorimotor intervention. The duration of the intervention lasted up to 60 minutes per session, one session per week for 8 weeks. After the intervention, reassessment was done using the screener of handwriting proficiency, then the results were recorded and analysed using the pre-test and post-test scores.

RESULTS: On comparing the pre-test and post-test scores of the screener of handwriting proficiency of 35 second-grade students with handwriting difficulty, there is an improvement in the total score of handwriting (< 0.001*) in components such as memory(< 0.001*), placement (0.023*), sentence (< 0.001*) except orientation (0.065) after receiving sensorimotor intervention.

CONCLUSION: The study concluded that there is a significant improvement in handwriting components such as memory, placement, sentence except orientation among primary school children with handwriting difficulties after receiving sensorimotor intervention.

KEYWORDS: Handwriting, Handwriting difficulties, primary school children, sensorimotor intervention.

I. INTRODUCTION

Handwriting is a written form of communication that is an essential occupation for many school-aged children. As writers express their thoughts through letter shapes, the fundamental units of written words and text, handwriting is a "brain-based skill that facilitates meaning-making." (1)

The complex process of writing requires integrating multiple skills including ideation, graphomotor function, language and reading comprehension, organization, memory retrieval, and problem-solving. The academic work of writing is supported by the functional skill of handwriting, which enables students to complete school projects on time and effectively communicate written information. (2)

Development of Prewriting and Handwriting in Young Children

Age	Level Performance Task
10-12month	Scribbles on paper
2 year	Imitates horizontal, vertical, and circular marks on paper
3 year	Copies a vertical line, horizontal line, and circle
4-5year	Copies a cross, right oblique cross, some letters and numerals.

It was discovered that handwriting in children exhibiting typical development showed a rapid rise in handwriting quality during grade 1 (ages 6–7), which peaked by grade 2 (ages 7–8). By third grade (ages 8 to 9), handwriting advanced to the point where it became automatic, well-organized, and also a tool to help with concept expression. (3)

Typically, the dynamic tripod grasp is recommended as the correct grip for handwriting. Which involves the thumb, index, and middle fingers functioning as a tripod. This grasp allows small, well-coordinated 4 movements of the involved fingers. When working with children with handwriting difficulties, occupational therapists will frequently assess the child’s pencil grasp and then provide intervention by altering the pencil grasp. (4)

The prerequisites for handwriting include visual-motor coordination, motor planning, cognition, visual perception, and sensory processing, particularly in the tactile and kinaesthetic senses. Visual perceptual skills, visual motor skills, motor planning and sequencing, bilateral coordination, hand-eye coordination, and other specified skill areas act as a barrier for an individual to participate in handwriting and other fine motor skills. (6)

In evaluating the actual task of children's handwriting the following areas need to be examined such as domains of handwriting (near point copying, far point copying, writing dictated word, generation of a sentence) legibility components also known as readability (improper letter form, poor leading in and out of letters, inadequate rounding of letters, incomplete of closure of letters incorrect letter) writing speed (rate of writing) and ergonomic factors (posture upper extremity stability). Children who struggle with handwriting

have issues with writing works in school. It frequently requires a lot of time and effort for students to learn how to write clearly. The following are possible outcomes of handwriting difficulties in the school: Students may take longer time to complete assignments than their peers, students slow handwriting speed may limit compositional fluency and quality, teachers may assign lower marks for papers and tests with poorer legibility but not lower content, writing avoidance may develop, Students may struggle to take notes in class and read them later, Students may fail to learn other higher-order writing processes such as planning and grammar. (2)

The efficacy of occupational therapy interventions and strategies for handwriting-related problems has been shown in numerous researches. The current state of occupational therapies is based on the sensorimotor, biomechanical, psychological, cognitive, acquisitional, and motor learning strategies.

The sensorimotor approach states that writing by hand is a difficult process that needs efficient application of sensorimotor skills in addition to efficient memory preservation and recall techniques Sensorimotor skills associated with handwriting include visual-motor integration, fine motor control, in-hand manipulation, bilateral integration, motor planning, proprioception, and visual perception (10)In this study sensorimotor approach is used because a relationship exists between these lower-level processes and handwriting performance, and these skills will result in improved handwriting. Therefore, occupational therapists usually classify handwriting difficulties into sensorimotor and perceptual components to identify the foundation skills associated with the functional skill of handwriting. Sensorimotor approaches use some combination of sensory input and motor activities to facilitate the expected normal motor response and promote motor skill development. (1) The sensorimotor system is defined as a component of the motor control system and is used to describe the integration of the neurosensory and neuromuscular processes responsible for providing the body with coordination and dynamic stability. The central nervous system processes and integrates neuromuscular control mechanisms, joint position sensation, and force perception as part of the sensorimotor system. (11)

Ayres described the sensory inputs and end products in her chart entitled, “the senses, integration of their inputs, and their end products," Ayres detailed the sensory inputs and outputs. The combination of the vestibular and auditory senses results in speech and language. Vestibular and proprioceptive sensors are integrated to produce eye movements, posture, balance, muscular tone, and gravitational security. Body perception, two-sided body coordination, motor planning, activity level, attention span, and emotional stability are all influenced by the vestibular, proprioceptive, and tactile senses. The vestibular, proprioceptive, tactile, and visual senses produce eye-hand coordination, visual perception, and deliberate activity. Focus, organization, self-worth, self-control, self-assurance, academic learning, abstract thinking and thought, and specialization of each part of the body and brain are all outcomes that depend on the senses working together. (12)

Screener of Handwriting Proficiency is a free and simple whole-class assessment tool that offers useful information on student's handwriting abilities and areas that require improvement through formative and summative evaluations. It is a tool that specialists can use to quickly and easily identify classes and students struggling with handwriting, Handwriting without tears, and a team of OT and educators developed the screener of handwriting proficiency. This whole class screening tool focuses on classroom instruction in handwriting by monitoring critical and measurable skill areas where students need instruction and intervention throughout the year.

Poor handwriting abilities and a lack of automaticity with handwriting increase a child's cognitive load and, as a result, limit their ability to use other cognitive capacities to improve the content of writing, even though proficient handwriting is known to have positive correlations with other academic skills.

II. NEED OF THE STUDY

Previous research shows that 34% of primary school-age children having handwriting difficulties. Handwriting difficulties are one of the main reasons for occupational therapy referrals from teachers. [7] There is a need for early detection and intervention as 7-8 years is the ideal age for skilled hand handwriting in primary school children [2] and persistent handwriting difficulties can limit their overall academic performance so, the role of occupational therapist is essential for students with handwriting difficulty.

III. AIM AND OBJECTIVES

AIM:

To study the effectiveness of sensorimotor intervention to improve the handwriting among primary school children with handwriting difficulties.

OBJECTIVES:

- To assess children with handwriting difficulties using screener of handwriting proficiency.
- To provide sensorimotor intervention to primary school children.
- To reassess handwriting using screener of handwriting proficiency.
- To compare pretest and posttest scores of children with handwriting difficulties

HYPOTHESIS

ALTERNATIVE HYPOTHESIS:

- There is significant improvement on handwriting after sensorimotor intervention among primary school children with handwriting difficulties.

NULL HYPOTHESIS:

- There is no significant improvement on handwriting after sensorimotor intervention among primary school children with handwriting difficulties.

IV. METHODOLOGY

RESEARCH DESIGN: Quasi-experimental study (Pretest-posttest study design)

SETTING OF THE STUDY: Government and private school children in Kovalam.

SAMPLING TECHNIQUE: Convenient sampling method was used.

POPULATION: Primary school children with handwriting difficulties.

SAMPLE SIZE: 35

VARIABLES:

- Independent Variables: sensorimotor based intervention.
- Dependent Variables: Handwriting skills

SELECTION CRITERIA

Inclusion criteria:

- Children between 7 to 8 years. [7]
- Children with both genders.
- Children having handwriting difficulties are assessed by a screener of handwriting proficiency**.**

Exclusion criteria:

- Children with Congenital physical disabilities.
- Children with Orthopedic conditions like fracture and injury.
- Children with Neurological deficits.

DURATION OF THE STUDY

60 minutes per session, one session per week for 8 weeks.

SCALE USED

SCREENER OF HANDWRITING PROFICIENCY. It assesses 4 components for 2nd-grade children such as Memory (88%), Orientation (86%), Placement (75%), Sentence (60%).

INTERVENTION PROTOCOL

SESSION	WARMUP ACTIVITY (10 minutes)	Break for (5min)	THEME	THEME BASED ACTIVITIES (40 minutes, in between break for 5 minutes)
1	Vestibular, proprioceptive, Tactile stimulation and finger activities	break	Visual motor integration	1)Tracing lines (20 minutes) Break (5 minutes) 2)Origami (20 minutes)
2	Vestibular, proprioceptive, Tactile stimulation and finger activities	break	Visual motor integration	1)String figure (20 minutes) Break (5 minutes) 2)Pyramid game (20 minutes)
3	Vestibular, proprioceptive, Tactile stimulation and finger activities	break	Oculomotor control	1)Oculomotor worksheets (look &find) (20 minutes) Break (5 minutes)

				2) Oculomotor activities (20 minutes)
4	Vestibular, proprioceptive, Tactile stimulation and finger activities	break	Oculomotor control	1)Oculomotor worksheets (look &find) (20 minutes) Break (5 minutes) 2)Oculomotor activities (20 minutes)
5	Vestibular, proprioceptive, Tactile stimulation and finger activities	break	Fine motor control	1)Cutting and pasting (20 minutes) Break (5 minutes) 2)Paper basketball game (20 minutes)
6	Vestibular, proprioceptive, Tactile stimulation and finger activities	break	Fine motor control	1)Paper tear painting (20 minutes) Break (5 minutes) 2)Finger maze (20 minutes)
7	Vestibular, proprioceptive, Tactile stimulation and finger activities	break	Visual perception	1)Number link puzzles (20 minutes) Break (5 minutes) 2) Long picture puzzle (20 minutes)
8	Vestibular, proprioceptive, Tactile stimulation and finger activities	break	Visual perception	1)Mirror drawing (20 minutes) Break (5 minutes) 2) Connect the dots game (20 minutes)

DATA COLLECTION

Permission was obtained from various schools through their correspondence and principal. The consent was collected from their parents. Screener of handwriting proficiency was used to assess the handwriting of children. Out of 100 children,35 children were selected for the study based on selection criteria. The children's pre-test value was recorded by using screener of handwriting proficiency. The children were given a total of 8 session (1 session per week) over 8 weeks each session lasting about 60 minutes. After 8 weeks, the post-test values were recorded.

V. RESULTS

Statistical Analyses: The collected data were summarized by using the Descriptive Statistics: frequency, percentage; mean and S.D. The Independent sample "t" test was used to compare the hand writing difficulties; according to gender as well as the prevalence. The Paired "t" test was used to find the effectiveness of sensorimotor intervention. The Chi square test was used to compare the prevalence of handwriting difficulties according to gender. To find the relation between the various domains of handwriting difficulties; the Pearson correlation coefficient: ("r") was used. The p value <0.05 was considered as significant. Data were analysed by using the SPSS software (SPSS Inc.; Chicago, IL) version 29.0.10.

Table 1: Gender distribution

(n = 100)		Frequency	%
Gender	Male	46	46
	Female	54	54

Among the 100 second grade students; the majority were females (54%); and the 46% were males. [Table – 1]

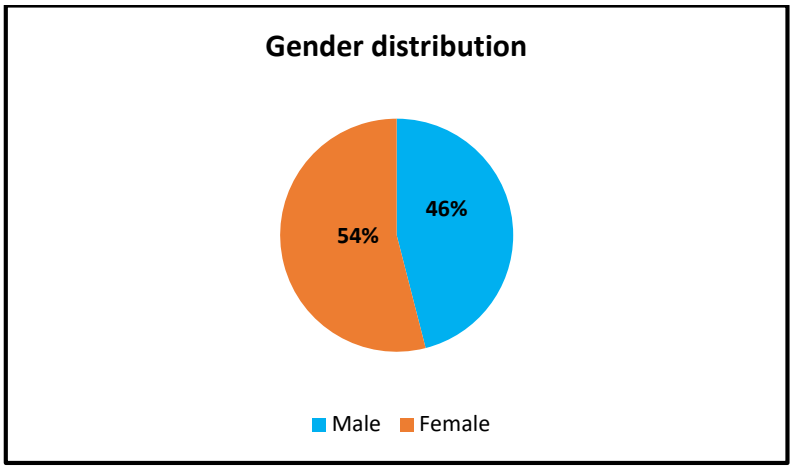

Figure 1: Shows gender distribution of 100 second grade students

Table 2: Prevalence of hand writing difficulties among the 100 second grade students

Prevalence		Frequency	%
Hand writing difficulties	With difficulty	35	35
	Without difficulty	65	65

Among the 100 second-grade students, 35 students (35%) reported experiencing difficulties with handwriting, while 65 students (65%) did not face any such difficulties.

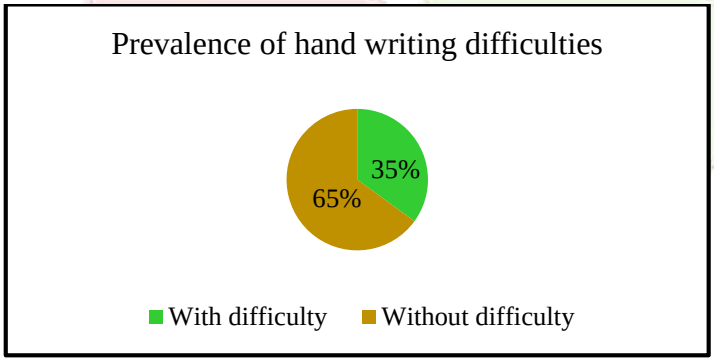

Figure – 2: Shows prevalence of handwriting difficulties among 100 second grade students.

Table 3: Prevalence of handwriting difficulties according to gender

Prevalence		Male		Female		Chi-square	p-value
		N	%	n	%		
Handwriting difficulties	With difficulty	17	37.0	18	33.3	0.143	0.705
	Without difficulty	29	63.0	36	66.7		

The prevalence of handwriting difficulties according to gender shows that 17 males (37%) and 18 females (33.3%) experience difficulties with handwriting. For those without difficulties, 29 males (63%) and 36 females (66.7%) do not have handwriting issues. The Chi-square value is 0.143, and the p-value is 0.705, indicating no significant gender difference in the prevalence of handwriting difficulties.

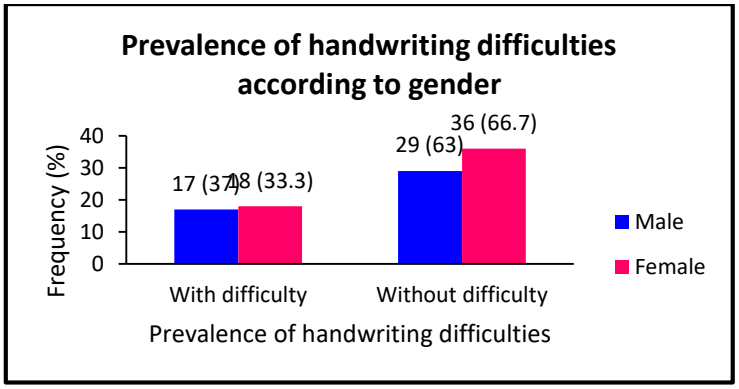

Figure – 3: Shows prevalence of handwriting difficulties according to gender**.**

Table 4: Effectiveness of sensorimotor intervention among the 35 second grade students with hand writing difficulty

		Pre-test		Post-test		"t"	p value
		Mean	S.D.	Mean	S.D.		
Memory	Student score	88.86	9.55	94.51	5.27	-7.29	< 0.001*
	Difference	-7.77	10.39	-2.57	5.35	-5.26	< 0.001*
Orientation	Student score	97.80	3.23	98.49	2.28	-1.91	0.065
	Difference	1.91	3.24	2.49	2.28	-1.65	0.108
Placement	Expectation	91.00	0	94.00	0	--	--
	Student score	97.54	5.53	98.69	3.05	-2.39	0.023*
	Difference	6.63	5.54	4.69	3.05	4.08	< 0.001*
Sentence	Student score	49.71	15.62	74.86	13.14	-13.27	< 0.001*
	Difference	-30.29	15.62	-5.14	13.14	-13.27	< 0.001*
Total score	Expectation	91.00	0	92.00	0	--	--
	Student score	83.37	4.82	91.71	4.39	-18.90	< 0.001*
	Difference	-7.63	4.82	-0.29	4.39	-16.63	< 0.001*

("t" = Paired "t" test; * Significant) The Paired "t" test was used to find the effectiveness of sensorimotor intervention; among the 35 second grade students with difficulty. There was an improvement in memory, placement, sentence, and the total score of handwriting from pre-test to post-test; among the 35 second grade students with difficulty. [Table – 8]

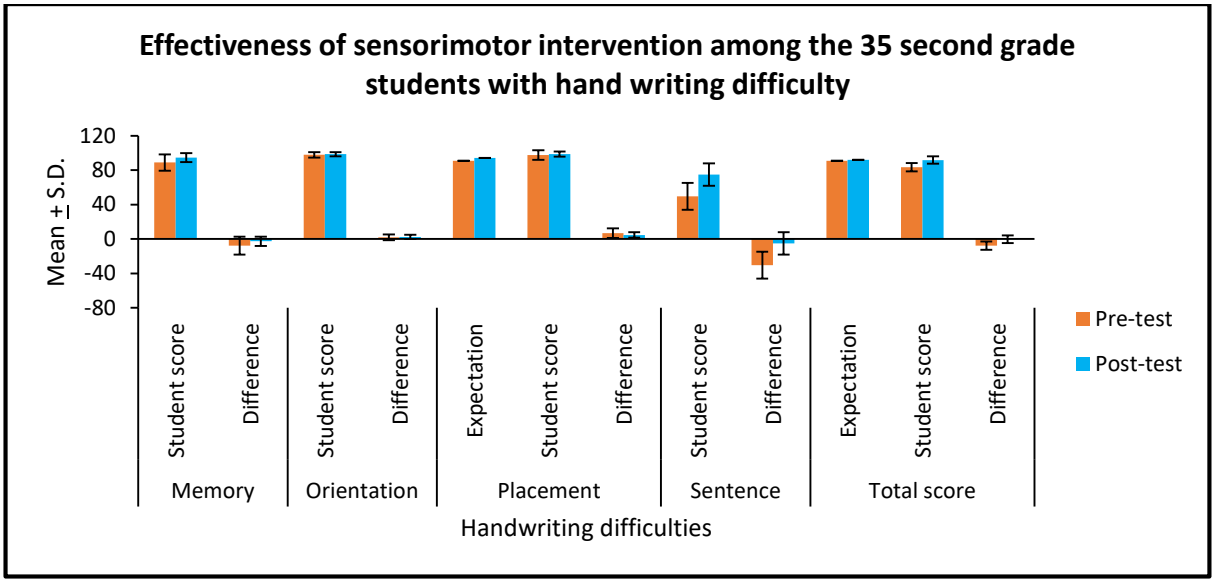

Figure – 4: Shows Effectiveness of sensorimotor intervention among the 35 second grade students with hand writing difficulty.

VI . DISCUSSION

The study aimed to assess the effectiveness of sensorimotor intervention to improve handwriting by using the screener of handwriting proficiency. This research focuses on the complexity of handwriting which requires the coordination of various motor, cognitive, and sensory processes, and also if any disturbances in these areas make an impact on children's handwriting which makes this research important. As highlighted in the study by Cecilia W.P. Li-Tsang and Tim M.H. Li, (10) a sensorimotor intervention can significantly improve handwriting skills, especially when administered over an extended period. In their study, children showed improvements in writing skills after receiving an 8-session group-based intervention. These findings align with the results from other studies, such as those by Adel A. Alhusaini and Sidney Chu (1), which suggest that sensorimotor-based interventions have a positive effect on legibility, form, alignment, size, and spacing, as well as on overall handwriting performance. The interventions, which target visual-motor integration, fine motor control, and tactile perception, help children overcome the basic motor coordination issues that cause handwriting difficulties.

Table 1 indicates the gender distribution of the 100 second-grade students. Among the students, 46% were male and 54% were female, with a higher proportion of females. The data presented in **Table 2** highlights the prevalence of handwriting difficulties among a sample of 100 second-grade students. Out of the 100 students surveyed, 35 students (35%) were found to have handwriting difficulties, while 65 students (65%) did not face such challenges. This suggests that a significant proportion of young students struggle with handwriting skills. In early education, handwriting is a foundational skill, crucial not only for academic performance but also for cognitive development, fine motor skills, and self-confidence. Therefore, 35% of students with handwriting difficulties may experience challenges in various aspects of their learning, potentially affecting their ability to complete written assignments, take notes, and express themselves clearly through writing. While the majority of the students (65%) in this sample do not exhibit significant handwriting difficulties, it remains important for educators to address the needs of those who do. In conclusion, the data indicates that

while the majority of students in this sample are not facing handwriting difficulties, a notable percentage (35%) are. Addressing handwriting difficulties in young students is crucial, as it can affect their academic performance and overall learning experience. Implementing targeted interventions, promoting fine motor skill development, and encouraging consistent handwriting practice can help alleviate these difficulties.

In the study conducted by Prof. Rhaguram and Dr. Ramachandram on second-grade students in South Chennai, it was found that 29.2% of students reported handwriting difficulties, with male students (37.5%) more frequently affected than female students (18.8%). This gender difference is consistent with findings from other studies, which suggest that boys are more likely to struggle with handwriting than girls. In this study the data **Table 3** presented on the prevalence of handwriting difficulties according to gender shows that, among the 100 second-grade students, 17 males (37.0%) and 18 females (33.3%) experience handwriting difficulties, while 29 males (63.0%) and 36 females (66.7%) do not. The chi-square test result of 0.143 and a p-value of 0.705 suggest that there is no statistically significant difference between the genders in terms of the prevalence of handwriting difficulties

After comparing the data from **Table 4** demonstrates the effectiveness of a sensorimotor intervention in improving handwriting skills among 35 second-grade students with handwriting difficulties. Significant improvements were observed in memory, placement, sentence writing, and overall handwriting performance, with p-values less than 0.001, indicating the intervention's effectiveness. Specifically, memory scores increased from a mean of 88.86 to 94.51, placement scores improved from 97.54 to 98.69, and sentence scores saw a remarkable rise from 49.71 to 74.86. However, the intervention had no significant effect on orientation, as the p-value for this measure was 0.065. Overall, the intervention proved successful in enhancing the students' writing abilities, especially in memory, sentence formation, and total handwriting performance, suggesting its potential for addressing handwriting difficulties in school children.

A study by Sidney Chu emphasized that children with handwriting difficulties often experience issues with task planning, sensory integration, and motor execution. These deficits are particularly evident in children with developmental disorders, such as dyspraxia and dyslexia, which require proper occupational therapy interventions. Occupational therapists use various strategies, to address these difficulties and help children build the necessary skills for legible and efficient handwriting.

VII. CONCLUSION

This study is aimed to find the effectiveness of sensorimotor intervention to improve the handwriting among primary school children with handwriting difficulties. The study was done on 35 second grade children after screened about 100 children using screener of handwriting proficiency. The participant received weekly occupational therapy sensorimotor intervention to improve handwriting for 8 weeks (8 sessions). The pre-test and post-test were done using the screener of handwriting proficiency. The study shows significant improvements in handwriting through incorporation of sensorimotor intervention. This study supports the effectiveness of sensorimotor interventions in improving handwriting skills, especially with early

implementation for consistent period of time. Occupational therapists play a crucial role in evaluating handwriting difficulties and providing intervention using evidence-based strategies to help the children to overcome these challenges.

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