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Screening of Visual-Motor Integration (VMI) and how VMI affects handwriting in 4th and 5th grade children of urban English medium schools

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ABSTRACT

To screen 4th and 5th-grade school children from urban English medium schools for Visual-Motor Integration (VMI) and how VMI affects handwriting. The objective of this paper is to determine the relationship between VMI and handwriting skill among children of 4th and 5th grade of English medium school in Nagpur city and the impact of visual-motor integration skills on handwriting legibility. Elementary school Children were assessed for Visual-Motor Integration by Beery Buktenika's Developmental Test of Visual-Motor Integration (VMI) by the examiner. The Beery's VMI and its two supplemental standardized tests i.e visual perception and motor coordination, provide one of the most valid and economical visual motor screening batteries available for preschool to adult ages. Results- This study shows that percentage of children having standard scores of VMI below average to very low scores was 26.48% which is similar to the standard score interpretation of Beery VMI in which 25% of children fall under the below average to very low standard score category. In this study we found that the percentage of the age group in below average was 12.52% with one standard deviation below the mean, low was 9.79%, and very low was 4.17%, respectively. Whereas in Beery's VMI Standard Score Interpretation, the percentage of the age group in below average is 16%, low is 7% and very low is 2% respectively. From this, we concluded that in this study, there is a 2% to 2.5% increase in the low and very low-performance category. The results of the item of copying forms from the visual perception show a significant relationship with the quality of handwriting that confirmed the results of other studies these studies used the VMI (Beery, 2004) and a copy of text to measure the quality of handwriting.

Keywords— *Visual-Motor Integration, Visual perception, Motor co-ordination, Handwriting*

1. INTRODUCTION

Visual-Motor Integration (VMI) is the ability of the eyes & hands to work together in smooth, efficient patterns. It involves visual perception and eye-hand co-ordination. Visual-Motor skills require the ability to translate visual perception into motor functioning and involve motor control, motor accuracy, motor co-ordination and psychomotor speed, so that children are able to copy, draw, or write what they see. The Developmental Test of Visual-Motor Integration (Beery VMI) is a widely accepted tool for the standardized assessment of VMI skills (Beery & Beery, 2010). The assessment contains two optional supplemental subtests: Visual Perception (VP: matching geometric shapes) and Motor Coordination (MC: tracing geometric shapes). The purpose of these subtests is to allow Occupational Therapists to compare a child's VMI results to their relatively pure visual and motor performance, to reveal whether the VMI skills are actually the issue, or whether VP or MC difficulties are pulling down their VMI score- the two foundations of VMI.

Effective coordination of the visual and motor system can only happen when the two foundations are well established. A delay in any of these areas may affect VMI skills. If a child's eye movements are poor this can also affect VMI. However even if both bases are good, VMI can still be poor, as it is the integration or coordination of two skills that is important.

1.1 Visual Skills Foundation (VSF)

The VSF is established through the development of:

- Visual perceptual skills
- Functional visual skills (e.g. Eye tracking and convergence)
- Eye-hand coordination

1.2 Motor Skills Foundation (MSF)

The MSF is established through the development of:

- Shoulder girdle stability
- Fine motor skills
- Eye-hand coordination

2. METHODOLOGY

The study was conducted at English medium schools of CBSE and state board pattern of Nagpur city. These English medium schools mainly catered to students from the middle socioeconomic background. Each school Principal was explained about the importance of visual -motor integration, visual perception and motor co-ordination, the time duration and the outcome of the study. In this regard a power point presentation was also given. They were explained about how this study would help determine children with handwriting difficulties as well as plan for early intervention.13 schools were visited out of which 7 refused to take part in the study, however 6 schools were selected for further evaluation.

The Institutional Ethical Committee (IEC) GMCH Nagpur approved all material and procedure for this study. The school participating in the study also approved the material and procedure for the study. Evaluation were scheduled during the school day. The students were evaluated inside the classroom at a classroom table typically used as a student work area.

2.1 Inclusion criteria

Typically developing children of 4th and 5th grade of English medium schools.

2.2 Exclusion criteria

If known physical Disability prevented them from effectively holding a pencil to write, a cognitive disability affected their Ability to complete Reading or writing tasks, or they were unable to follow commands in English as well as Hindi language.

Sample size was calculated considering prevalence of VMI difficulties amongst elementary school children as reported in previous studies of 15% with relative precision of 20% and 95% confidence level, minimum sample size required for this study was 590. Hence during my study period, I had included 623 children in the study.

$$N = Z^2_{1-\alpha/2} * p * (1-p) / d^2$$

Where,
p = anticipated prevalence of VMI difficulties
d = Relative precision
1-α/2 = confidence level
Z= Standard Normal variate

2.3 Demographic data

The students were asked to write the name, chronological age, sex, date of birth and date of evaluation on Beery's VMI, Motor coordination, visual perception and ETCH Response sheets. Elementary school children were assessed for Visual Motor Integration by Beery Buktenika's Developmental test of Visual Motor Integration (VMI) by the examiner.

The Beery's VMI and its two supplemental standardized tests, visual perception and motor coordination, provide one of the most valid and economical visual motor screening batteries available for preschool to adult ages. Both of the standardized supplementary test were administered individually after the Beery's VMI. All three standardized test were administered in valid order which is as follows.

- Berry VMI
- Visual perception
- Motor coordination

Method that require 2 or more adults as volunteers with 20 + children at one time coupled with good follow up by the specialist with the classroom teacher, was the most effective method of administration .It took around 20 minutes to complete the screening. It was a faster and inexpensive method to screen children as compared to other methods which consisted of 2 + children or one child at a time.

2.4 Inter-scorer reliability

The inter-scorer reliabilities of the BEERY's VMI, and of its Visual perception and Motor Coordination subtests were. 94, .97 and .92 respectively.

2.5 Scoring for Beery's VMI

In Beery's VMI 1 point for each imitated or copied item upto 3 consecutive failures is given to obtain a raw score, the number of items that are not successfully completed prior to this ceiling of 3 consecutive failures is subtracted from the ceiling. For example if a child fails items 5, 8 and 11 -13 the raw score is 13.-5 =8. These scoring criteria and procedures apply to both beery VMI Test forms the full and short forms. The recording and scoring sheet (page 23 in the full form and page 15 in the short form shown on page 24 lists the "age norm " for each form, the age at which about 50% of children meet the developmental criteria for a given form. Beery VMI scoring is based on SCORE and NO SCORE criteria. Elementary school Children were also assessed for handwriting skills by Evaluation Tool of Children Handwriting –Manuscript (ETCH-M). These measures consist of 7 components which are as follows. The tasks to be performed by the child includes:

- Alphabet writing by memory (lower case and upper case)
- Numerical writing by memory (from number 1 to 12)
- Near point copying (from a copying sheet kept 3 inches from the top of child response sheet)
- Far point copying (from a wall chart 6 to 8 ft from child's desk and 4 feet above the ground)
- Dictation (contains 10 letters and 5 numerals)
- Sentence Composition (sentence should contain at least 5 words)

2.6 Inter-rater reliability

Total word legibility is more reliable than task scores.
Experienced raters: high (ETCH -M, 85; ETCH-C.90)
Experienced and inexperienced raters: high (ETCH -M. 75; ETCH-C.98)
Total ETCH legibility score are calculated for word, letter and numeral writing

3. RESULT

Table 1: Distribution of children according to standard score of VMI and age in years

Standard score	Number of children	Percentage	Performance
>129	0	-	Very high
120 – 129	45	7.22	High
110 – 119	102	16.37	Above average
90 – 109	311	49.92	Average
80 – 89	78	12.52	Below average
70 – 79	61	9.79	Low
<70	26	4.17	Very low

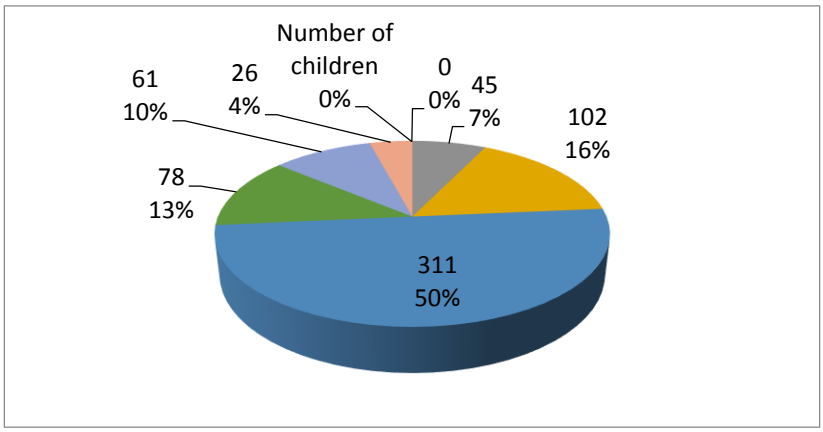

Fig. 1: Distribution of children according to standard score of VMI and age in years

Table 2: Correlation of standard score of beery VMI, visual perception and motor coordination with handwriting ETCH (Word, Letter and Numerals)

	Handwriting Etch					
	Word		Letter		Numerals	
	r-value	p-value	r-value	p-value	r-value	p-value
Beery VMI	0.2240	<0.0001, HS	0.0398	0.3239, NS	-0.0672	0.0961, NS
Visual perception	0.0621	0.1241, NS	0.3643	<0.0001, HS	0.0379	0.3483, NS
Motor coordination	0.1060	0.0085, HS	0.1377	0.0006, HS	0.0518	0.1998, NS

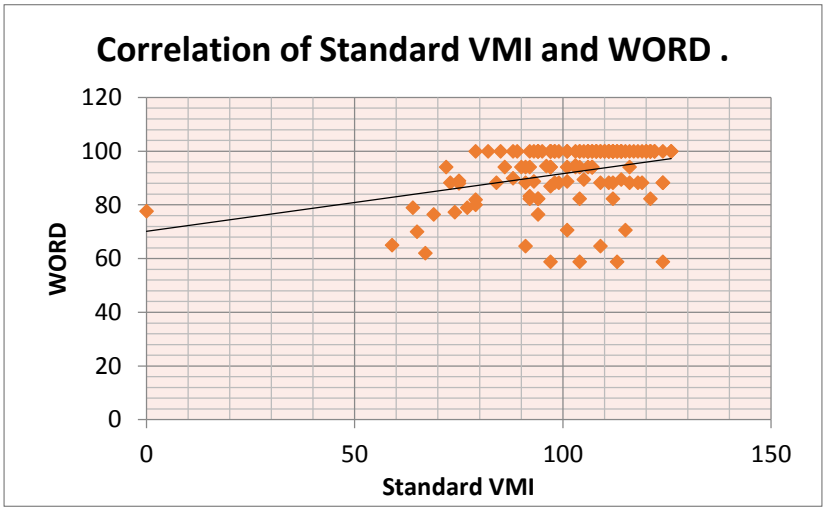

Fig. 2: Correlation of Standard VMI and WORD

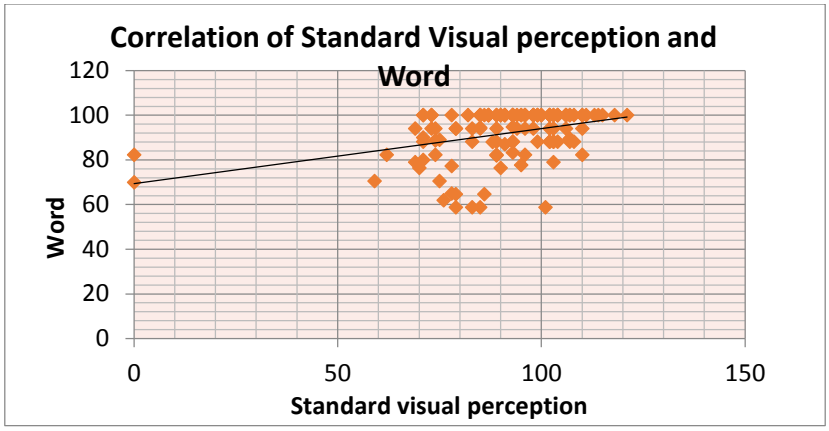

Fig. 3: Correlation of Standard Visual perception and Word

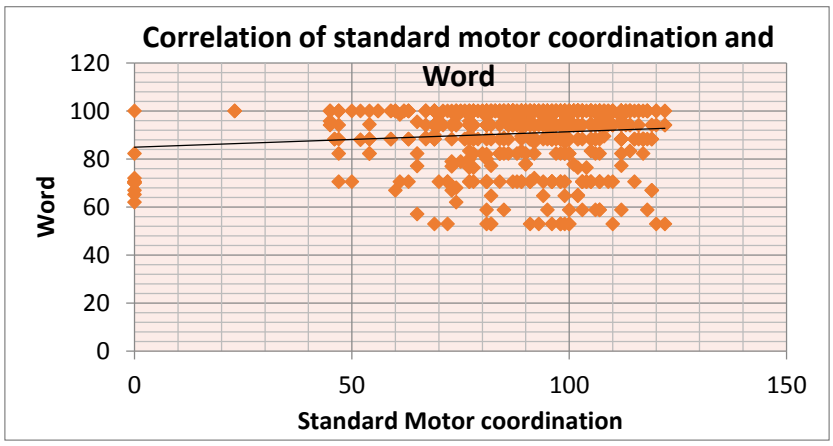

Fig. 4: Correlation of standard motor coordination and Word

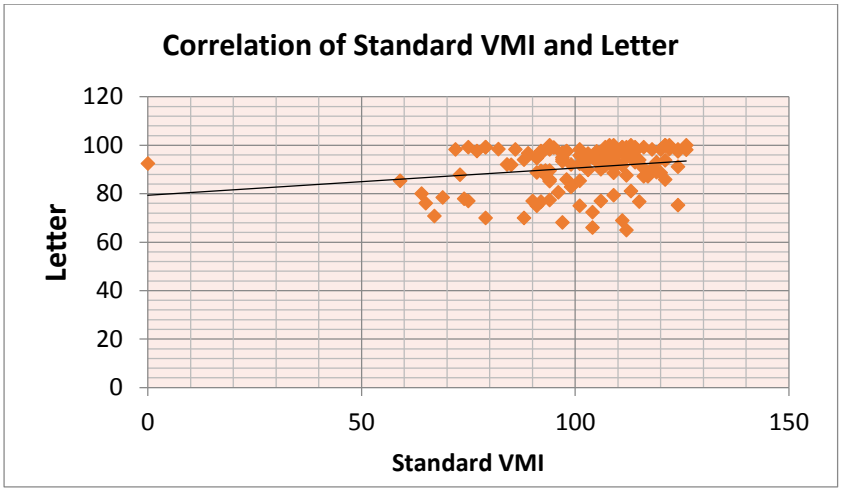

Fig. 5: Correlation of Standard VMI and Letter

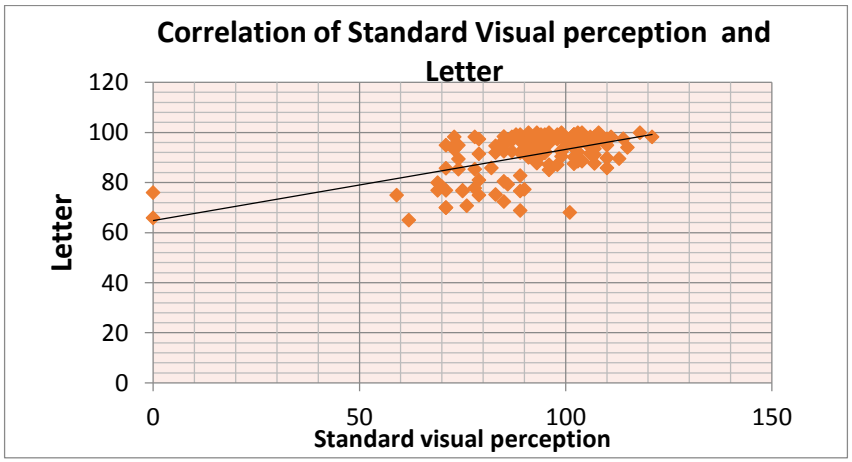

Fig. 6: Correlation of Standard Visual perception and Letter

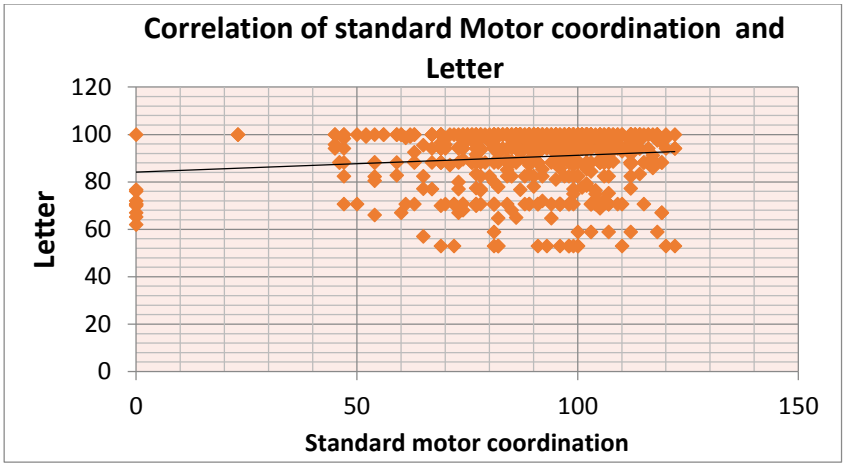

Fig. 7: Correlation of standard motor coordination and letter

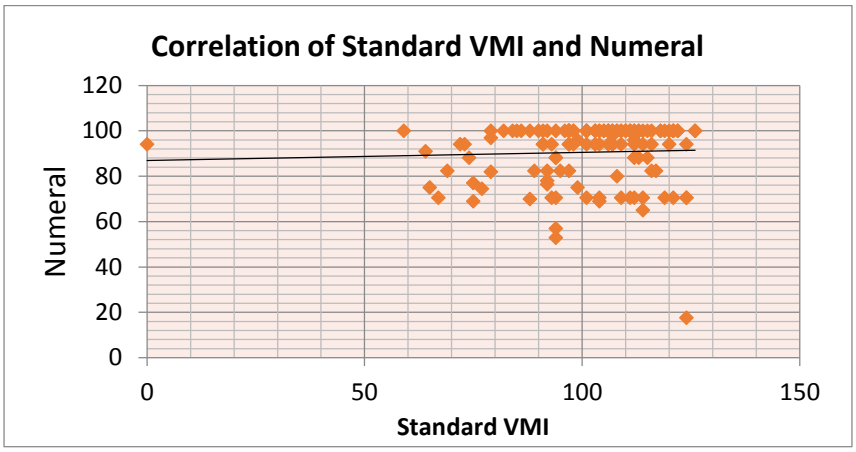

Fig. 8: Correlation of standard VMI and numeral

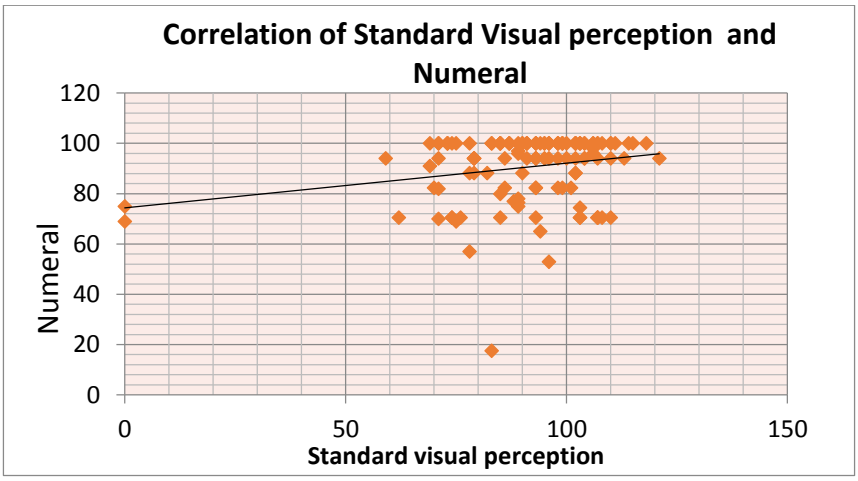

Fig. 9: Correlation of standard visual perception and numeral

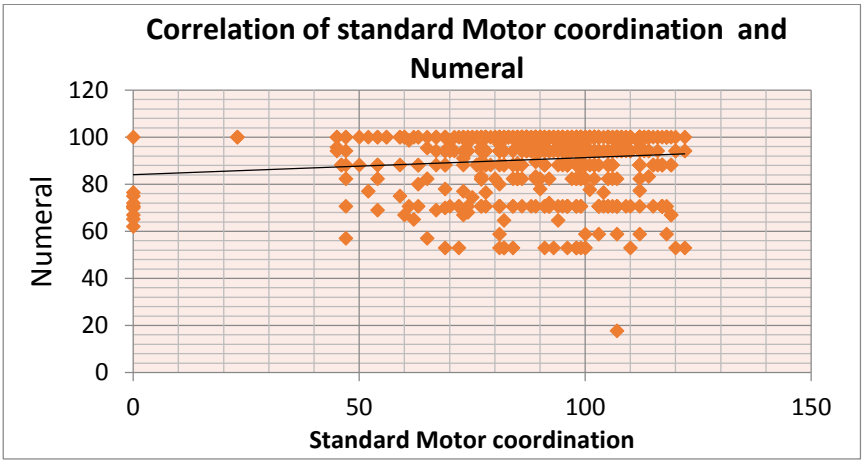

Fig. 10: Correlation of standard motor coordination and numeral

4. DISCUSSION

This descriptive cross-sectional study was conducted on 623 students from grade 4th and 5th from urban English medium schools. They were measured on Beery's visual-motor integration and its supplementary tests of visual perception and motor coordination. This study shows that percentage of children having standard scores of VMI below average to very low scores was 26.48% as depicted in table no 1. This is similar to the standard score interpretation of Beery's VMI in which 25% of children fall under the below average to very low standard score category. In this study we found that the percentage of age group in below average was 12.52% with one standard deviation below the mean, low was 9.79%, and very low was 4.17%, respectively whereas in Beerys VMI Standard Score Interpretation, percentage of age group in below average is 16%, low is 7% and very low is 2% respectively. From this we conclude that in this study, there is a 2% to 2.5% increase in low and very low performance category.

Table no 2 shows the correlation between Beery VMI and word legibility in which r- value is 0.2240 and p value is < 0.0001 which is highly significant. Our study is in coherence with previous study done by (Corlhill and Case Smith, 1996; Karlsdottir and Stefalsson, 2002; Tseng and Murray 1994) which stated that 'The results of the item of copying forms from the visual perception shows significant relationship with the quality of handwriting that confirmed the results of other studies these studies used the VMI (Beery, 2004) and a copy of text to measure the quality of handwriting'. Several studies have supported the relation between the functioning of different sensory systems and handwriting performance. In a study done by (Weil & Cunningham Amundson, 1994) comparing visual motor integration, as measured by the Beery's VMI and legible copying ability in handwriting, as measured by the Scale of Readiness in Printing (SCRIPT), the authors found a significant positive correlation between visual motor abilities and legible copying. A similar study by Daly, Kelley and Krauss (2003) supported Weil and Cunningham Amundson's (1994) study. These authors found that visual-motor integration skills were related to the ability to copy letters when comparing the subjects' performances on the VMI and Modified SCRIPT. They also concluded that there was no significant difference in letter writing legibility between students who use paper with or without lines. The results of these studies support the identification of visual motor integration as a requisite skill for handwriting legibility.

A more recent study by Volman, van Schendel and Jongmans (2006), investigated the relationship between handwriting abilities and visual-perception, visual-motor integration, fine motor coordination and cognitive planning among elementary aged children, thus supporting the findings of Cornhill and Case-Smith (1996), Weil and Cunningham Amundson (1994), and Daly, Kelley and Krauss (2003). The study results showed that children with handwriting problems appear to perform less proficiently on measures of skill areas explored in this study. The authors were further able to identify two different mechanisms underlying handwriting quality. Their results indicated that good fine motor coordination was the only significant predictor of quality of good handwriting and that poor handwriting quality was particularly related to deficits in visual-motor integration.

Weintraub & Graham, 2000; Williams, Zolten, Rickert, Spence, & Ashcraft, 1993; Yochman & Parush, 1998). Volman, van Schendel, and Jongmans (2006) found significant correlations between visual–motor integration and the quality of handwriting in children with developmental coordination disorder.

5. CONCLUSION

This study highlights the importance of handwriting skills in 4th and 5th grade students and the relationship between VMI along with VP and MC and ETCH. we also concluded that as there is a rise of about 2% to 2.5% of children lying under low to very low category of Standard Score Interpretation of Berry's VMI hence to remediate these issues in children they need to be referred to Occupational therapist for early evaluation and appropriate remediation strategies can be administered which will help the child in overcoming challenges faced in performance areas. Care givers, teachers and family members can be counselled regarding intervention and social support systems can be built for children with under addressed problems of visuo-motor integration.

6. LIMITATIONS

The limitations of this study were that it did not involve a cognitive aspect, children with hearing and vision problems, chronic diseases, children having intellectual disability as well as children with ADHD and other neurological deficits were also excluded from this study.

7. FUTURE IMPLICATIONS

Suggestions for further research are to examine the effectiveness of activities used more often in the remediation of handwriting problems, modify the survey item regarding primary sensory systems to specify the number of responses sought, and carry out a qualitative study that addresses clinical reasoning of school-based therapists. The present study has important ramifications to simplify the identification approaches to advocate the need for planning and developing public health interventions and explaining educational policies as well as appointing an Occupational Therapy professional for every school to intervene for the handwriting, visual-motor integration problems and other related issues

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