Gender and grade differences in handwriting performance among the school children

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Abstract

The aim of the study was to assess the Gender and Grade differences in Handwriting Performance among 6-12 years old School children. A total of 1096 students of grade 1-6 were screened out using Handwriting Proficiency Screening Questionnaire, out of which 34.48% students found to have Handwriting deficiency. The mean age of children was 9.02 years. Children having manuscripts handwriting format were selected for the study. The handwriting performance of the student was assessed using Evaluation Tool of Children's Handwriting-Manuscript (ETCH-M). Result showed that overall, 67% of boys and 33% of girls had handwriting difficulties. Handwriting of the girls was more legible as compared to the boys. Girls were faster writer than the boys. When Handwriting performance were analysed according to the grades study showed handwriting speed and legibility improves from grade to grade. Result also showed the negative correlation between the Writing speed and legibility ranging from r=-0.09 to -0.14 (gender) and r=-0.22 to -0.51 (grade). There was significant difference in the quality or speed scores among the students using different pencil grasps. Thus, the study concluded that, school authorities should carry out children's screening for handwriting performance on regular basis so that handwriting issues can be solved as early as possible.

Keywords: Handwriting performance, School-children, Gender differences

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Introduction

Handwriting is an important skill learned during the early school years. For children, academic school activities can be considered as a major domain of their occupational work performance [1]. Handwriting is an important means of communication that enables the expression, recording, and transmission of ideas of students throughout their educational careers. It has been estimated that elementary school-age students may spend up to one-half of their school day in performing handwriting and other paper-pencil tasks which is important for success at school [2].

There are many components that must be considered when assessing and working with a child regarding handwriting, i.e., Legibility, Writing Speed, and Domains of Handwriting. Legibility involves letter formation, alignment, spacing, and size. Writing Speed, it is defined as the number of letters written per minute and Domains of Handwriting i.e., writing the alphabets in both upper and lower case from memory, dictation, near and far point copying [3]. Handwriting is often the important means that helps the school-age children to participate in learning tasks and transcribe written narratives. Therefore, it is essential to understand the nature of handwriting difficulties for children who are at risk for handwriting dysfunction [2]. For assessing and defining poor handwriting: product legibility, performance time, spacing between letters or words, shaping of the letter, letter reversals, and Letter case (upper and lower case) and pencil grip are the main outcomes that must be considered [4]. It is being suggested that the children with handwriting deficiency most commonly demonstrate the problems with legibility and slow writing speed. Thus, these children have difficulty in maintaining the required pace of writing in class [5,6]. The children with handwriting difficulties also face problems in the fluency and quality of their compositions. Illegible handwriting often results in lower scores in class and significantly affects the progress of a child in the classroom leading to academic underachievement [7].

Unfortunately, handwriting difficulties are commonly observed in children at primary schools and particularly in boys. It is reported that the prevalence of handwriting difficulties among school-age children varies between 10-34% depending on grade, selection criteria, and instruments used [8]. The limited numbers of studies are available in India considering the Handwriting performance among school children. Hence the purpose of the study was to assess the Gender and Grade differences in Handwriting Performance among 6-12 years old School children. With this purpose, the study aimed to answer following questions.

1. Is there is any gender and grade related difference in handwriting speed and legibility scores achieved on the ETCH-M?

2. If there is any gender and grade related difference in letter reversals shown by the students?

3. Is there any association between the handwriting speed and handwriting legibility?

4. What is the effect of pencil grip on handwriting speed and legibility?

Materials and Methods

Subjects

The comparative study was conducted in regular schools of South Delhi, India for the period January 2020 to April 2020. Both boys and girls with age between 6-12 years, attending school in a regular educational environment were included.

Table 1. *Participant characteristics (N=1296).*

Demographics	Frequency	Percentage
Age (M = 9.15 years, SD = 1.89 years)		
6-7 years old	111	29%
7 -8 years old	135	36%
9-10 years old	74	20%
11-12 years old	58	15%
Gender		
Boys	253	67%
Girls	125	33%
Grade Level		
First	50	13%
Second	55	15%
Third	69	18%
Fourth	72	19%
Fifth	74	20%
Sixth	58	15%
Handedness		
Right	336	89%
Left	42	11%
Pencil Grip		
Static Grip	151	40%
Four Finger Grip	34	9%
Crossed Thumb Grip	38	10%
Lateral Tripod Grip	72	19%
Dynamic Tripod Grip	83	22%

Students having other medical, psychiatric, or neurological disorders were excluded. A total of 1096 students of grade 1-6 were screened out using Handwriting Proficiency Screening Questionnaire, out of which 378 (34.48%) students found to have Handwriting deficiency. The mean age of children was 9.02 years. Overall 67% of boys and 33% of girls had handwriting difficulties on HPSQ. 89% of students were right-handed and 11% of students were left-handed. Children having manuscripts handwriting format were selected for the study (Table 1).

Procedure

Permission was taken from the school. Written consent was taken from each child's parents/guardians. Based on the inclusion students of the class 1st to 6th in the age group of 6 to 12 years were selected for the study. Their age was confirmed from the school records with the help of class teachers. Handwriting proficiency screening questionnaire was applied for all the children (filled in by school teachers). Written consent was taken from each child's parents/guardian who showed difficulty in handwriting. Children were assessed using Evaluation Tool of Children's Handwriting-Manuscript (ETCH-M) and Schneck and Henderson's [9] developmental grip scale. Following that gender and grade related difference in Handwriting Performance was assessed.

Outcome measures/scales

Handwriting proficiency screening questionnaire (HPSQ) [4]

Handwriting Proficiency Screening Questionnaire (HPSQ) developed by Sara Rosenblum. The HPSQ is a ten-item, reliable and valid questionnaire developed to identify school-aged children with handwriting deficiency based on their teacher's observation. Items are scored on a 5-point Likert scale from 0-never to 4-always, and then summed to a final score. Evaluation Tool of Children's Handwriting-Manuscript (ETCH-M) [10]. The ETCH-M is a criterion-referenced, standardized tool that evaluates legibility and speed of manuscript writing and includes six different writing tasks reflecting classroom performance demands (lower/upper-case alphabet writing, numeral writing, near-point copying, and far-point copying, dictation, and sentence composition). Domains of letter, word, and numeral legibility incorporate all tasks combined and are expressed as total legibility percentages based on the number of readable letters, words, or numbers subtracted from the possible number in each case. Writing speed is calculated for all tasks except dictation. The test–retest reliability coefficients for first and second grade children are 0.71 for total word legibility, 0.77 for total letter legibility, and 0.63 for total numeral legibility [5,6].

Schneck and Henderson's (1991) developmental grip scale

Schneck and Henderson's (1990) developmental grip scale describes 10 pencil and crayon grips and in 1991 she collapsed the 10 grips in the original scale into five levels. Pencil grip posture was assessed with a 5-point rating system with 5 being the highest score possible. [11].

Data Analysis

Complete data was gathered in the form of a master chart made on Microsoft Excel 2010. The statistical analysis was conducted using Statistical Package for the Social Sciences 21 (SPSS v.21). Pearson correlation analysis and regression analysis were performed to find out the correlation and significant predictors of handwriting legibility and speed ($p<0.50$). One-way analysis of variance (ANOVA) was carried out to find out the differences in word and letter legibility

among boys and girls of different grades, and to assess the effect of pencil grip on legibility and speed. Descriptive analysis included percentages, means, and SD.

Results

A total of 1096 students of grade 1-6 were screened out using Handwriting Proficiency Screening Questionnaire, out of which 378 students found to have Handwriting deficiency (HPSQ Score=26.15 ± 2.58).

Handwriting legibility

There was a significant difference in word legibility (t =15.90; p=0.00) and letter legibility (t =10.18; p=0.00) between the boys and girls, with lower scores were obtained for boys. Simple Regression analysis demonstrated a significant association between gender and legibility (r=0.11; p=0.02) (Table 2).

Table 2. *Gender related differences in legibility and speed score.*

Variables	Boys	Girls	t value	Significance level (p value)
	N=854	N=442		
ETCH-M	**M ± SD**	**M ± SD**		
Legibility				
Letter, %	60.23 ± 18.71	71.12 ± 10.50	10.18	0.00**
Word, %	42.10 ± 23.02	60.34 ± 18.09	15.9	0.00**
Speed				
Lower-case alphabet writing, s	183.36 ± 6.50	88.70 ± 6.90	194.25	0.00**
Upper-case alphabet writing, s	214.65 ± 9.30	115.05 ± 18.90	591.52	0.00**
Near-point copying, letters/min	12.29 ± 4.31	14.81 ± 4.91	6.99	0.00**
Far-point copying, letters/min	10.50 ± 2.29	12.51 ± 5.13	7.96	0.00**
Sentence composition, letters/min	9.94 ± 3.00	13.02 ± 4.61	11.07	0.00**

Table 3. *Mean, SD value of legibility score for each grade.*

Variables Legibility	Gender	First	Second	Third	Fourth	Fifth	Sixth
Letter, %	Boys	56.23 ± 17.34	58.29 ± 16.91	59.89 ± 14.67	61.18 ± 14.48	62.16 ± 15.38	63.53 ± 22.68
	Girls	63.71 ± 16.94	67.23 ± 14.10	68.54 ± 12.45	70.41 ± 6.80	71.68 ± 10.02	72.63 ± 8.71
Word, %	Boys	44.07 ± 23.47	45.98 ± 24.19	46.32 ± 21.83	51.13 ± 26.12	55.57 ± 75.46	57.57 ± 75.46
	Girls	56 ± 11.42	57.92 ± 21.97	59.35 ± 19.00	61.34 ± 16.30	63.88 ± 15.65	64.14 ± 19.76

Results of One-way ANOVA revealed the significant difference in word legibility, [Boys: F (5, 378) =2.19, p=0.054, Girls: F (5, 378) =2.47, p=0.032] and letter legibility, [Boys: F (5, 378) =3.02, p=0.010, Girls: F (5, 378)=3.58, p=0.003] among the students of different grades, with lower scores were obtained for students of grade first and second (Table 3).

Handwriting speed

Writing speed was assessed for copying, dictation, and sentence composition tasks. Result of paired t test showed that boys demonstrated significantly slower speeds as compared to girls in all the tasks (p=0.000; Table 2). The average numbers of letters written by boys-girls in one minute were 10-13 letters in first grade, 12-14 letters in second grade, 13-17 letters in third grade, 15-18 letters in fourth grade, 18-21 letters in fifth grade and 20-25 letters in sixth grade. Hence, most of the students of grade First, second and third showed slower speeds as compared to the students in other grades. Overall the students demonstrated slower speed during far-point copying task as compared to near-point copying, Dictation, and sentence composition (Table 4).

Table 4. *Average writing speed (No of letters per minute) and Letter Reversals of the children with handwriting deficiency in accordance with the gender and grade.*

Grades	Gender	Near-point copying		Far-point copying		Dictation		Sentence composition (Memory)	
		LPM	Reversals	LPM	Reversals	LPM	Reversals	LPM	Reversals
First (N= 50)	Boys	10.34	9.44	6.44	10.34	3.51	8.42	4.42	9.23
	Girls	13.12	5.21	8.36	6.55	6.05	4.36	8.18	5.47
Second (N=55)	Boys	12.71	6.63	8.63	7.23	5.23	9.1	7.27	8.56
	Girls	14.1	5.71	10.18	3.39	8.5	6.84	10.55	5.95
Third (N=69)	Boys	13.21	6.21	10.47	7.36	7.48	9.44	8.29	8.12
	Girls	17.36	4.55	13.36	3.32	9.62	6.48	11.07	4.18

Fourth (N=72)	Boys	15.72	5.12	12.39	6.18	9.95	8.51	11.25	6.84
	Girls	18.94	2.55	16.15	3.71	12.17	4.37	14.09	2.48
Fifth (N=74)	Boys	18.55	4.36	15.38	5.12	11.42	5.1	12.56	3.75
	Girls	21.44	1.63	18.32	3.48	13.48	2.54	17	1.36
Sixth (N=58)	Boys	20.58	2.65	18.23	3.79	13.57	2.2	15.51	2.48
	Girls	25.52	1.05	24.44	2.55	15.28	1.09	20.21	1.75

Letter reversals

Reversals produced by both boys and girls during near-point and far-point copying, dictation and sentence composition tasks were assessed for each grade. It was found that most of the boys showed Letter Reversals as compared to girls. Most of the students of grade first produced reversal during near-point and far-point copying task. Second grade students frequently reversed dictated letters and third grade students produced reversal during dictation and letter composition tasks. While the students of other grades demonstrated comparatively less reversals (Table 4). Also B, D, J, K, N, P, S, and Z were most commonly upper case reversed letters and b, d, h, j, p, q, s, t, and z were most commonly lower case reversed letters.

Correlation between legibility and writing speed

Regression analysis was carried out to examine the relationship between Legibility and writing speed. The relationship of handwriting speed on lower/upper-case alphabet writing, near-point copying, and far-point copying, sentence composition for both boys and girls was examined. The result showed the negative correlation between Writing speed and legibility, by gender as well as grade, ranging from r=-0.09 to -0.14 (gender) and r=-0.22 to -0.51 (grade) (Tables 5 and 6). Thus the finding indicated that the increase in student's handwriting speed leads to corresponding decline in the legibility.

***Table 5**. Correlation between Legibility and writing speed, by Gender.*

Speed	Gender	Lower-case alphabet	Upper-case alphabet	Near-point copying	Far-point copying	Sentence Composition
Word legibility	Boys	0.044	-0.099*	-0.019	0.007	-0.05
	Girls	0.01	0.008	0.044	-0.01	0.038
Letter legibility	Boys	0.01	-0.11**	0.016	-0.144*	0.011
	Girls	-0.02	-0.042	0.023	0.091	0.035

***Table 6.** Correlation between Legibility and writing speed, by Grade.*

Grade	Upper-case alphabet	Lower-case alphabet	Near-point copying	Far-point copying	Sentence Composition
			Letter legibility		
First	-0.50**	-0.51**	0.012	0.016	-0.416**
Second	-0.122	-0.17	0.04	0.042	-0.172
Third	0.013	0.043	0.012	0.002	-0.13
Fourth	0.031	-0.309**	-0.105	0.037	0.024
Fifth	0.033	-0.121	0.008	0.054	0.03
Sixth	0.004	-0.205	-0.184	0.072	-0.204
			Word legibility		
First	-0.326**	-0.256**	-0.208*	0.034	-0.220*
Second	-0.11	0.084	-0.227*	0.044	0.042
Third	-0.192	-0.209*	0.054	0.016	-0.366**
Fourth	-0.146	-0.135	0.016	0.059	0.041
Fifth	-0.108	0.08	-0.123	-0.119	-0.105
Sixth	-0.245*	0.079	-0.206	-0.128	0.031

Pencil grip

151 students used the static pencil grip, 34 used Four Finger pencil grip, 38 used Crossed Thumb grip, 72 used a Lateral Tripod pencil grip and 83 used a Dynamic Tripod pencil grip. (Table 1) Speed scores of boys and girls ranged from 12 to 25 letters per minute. Boys and girls using the Static pencil grip scored highest for both total word (51.02-61.75%) and total letter legibility (62.42-69.55%). And students who used Four Finger Grip scored lowest for both total word (36.02-42.07%) and total letter legibility (51.84-59.95%) as compared to the students using other forms of pencil grips (Table 7).

One-way ANOVA was carried out to assess the effect of pencil grip on legibility and speed. Results showed statistically significant difference between static grip, dynamic tripod, lateral tripod, Four Finger grip and Crossed Thumb grip for total word legibility F (4, 378) = 45.29, p=0.00, total letter legibility F (4, 378)=11.08, p=0.00, and speed scores F (4, 378) =69.71, p=0.00.

***Table 7.** Effect of pencil grip on Legibility and writing speed.*

Grip	Gender	Mean	Legibility	
		LPM	Word %	Letter %
Static Grip	Boys	20.13	51.02	62.42
	Girls	25.34	61.75	69.55
Four Finger Grip	Boys	12.84	36.02	51.84
	Girls	17.57	42.07	59.95

Crossed Thumb Grip	Boys	14.75	39.55	48.74
	Girls	19.95	48.84	61.81
Lateral Tripod Grip	Boys	16.03	42.02	52.01
	Girls	21.84	52.23	64.54
Dynamic Tripod Grip	Boys	18.42	48.22	55.34
	Girls	23.48	57	66.05

Discussion

This study was set out to examine the Gender and Grade related differences in Handwriting Performance among 6-12 years old School children. Out 1096 students of grade 1-6 were screened out using Handwriting Proficiency Screening Questionnaire, 34.48% students found to have Handwriting deficiency. Our result was supported by Kartsdottir and Stefansson [12], who did the study to assess the handwriting dysfunction among the students of 1-5th grade. Within the study, they found that 10-34% of school children failed to develop efficient handwriting performance required to cope at school.

Gender related differences in Handwriting performance

A total of 67% of boys and 33% of girls had handwriting difficulties on HPSQ. The boy-to-girl ratio is consistent with gender prevalence in handwriting issues as reported by Graham & Weintraub in their study [13]. When handwriting speed and handwriting legibility was assessed using ETCH-M result showed that boys performed significantly worse on handwriting performance compared with girls, demonstrating lower legibility and slower writing speeds and thus indicating the significant association between gender and handwriting legibility and speed. Our result is again supported by Kartsdottir and Stefansson [12] when the development of handwriting performance is analysed by gender, they found that girls performed better than the boys both in handwriting quality and speed.

Grade related differences in Handwriting performance

Results of One-way ANOVA revealed the significant difference in word and letter legibility among the students of different grades. The students of grade first and second demonstrated lower legibility as compared to students of other grades. Hamstra-Bletz and Blöte [14] in their study found the gradual improvement of handwriting legibility from grade 1 or grade 3 to grade 6 onward. Within the study we found that the writing speed of the students increased from grade to grade. But the pace of increase in speed for boys and girls was constant from grade 1-3 with 10-13 letters per minute, and the pace of handwriting speed increased to 18-25 letters per minute from grade fourth and sixth. Our result was supported by Feder K. and Majnemer A [5,6] who found that kids achieve speed and fluency with printing and become more automatic in their writing by the end of second grade (ages 8-9).

Thus on the basis of these studies we expected that the handwriting speed and legibility improves from grade to grade. Speed (average number of letters per minute) achieved by the students in our study are lower than the average writing speeds achieved by the primary school children in Graham et al. study [13,15]. The handwriting of the students was more legible during the copying task as compared to sentence composition. It might be possible because the students devoted the considerable attention on composition rather that to write neatly [13].

Is there any association between the handwriting speed and handwriting legibility?

On examining whether the handwriting speed contribute to legibility, Regression analysis showed the negative association between handwriting speed and legibility. Similar results were found in the study by Graham et al. [13] who assessed the relationship between the handwriting speed and legibility in 1-9 grade students and found that the correlation between Writing speed and legibility was weak ($p=-0.20$ for copy legibility, $p=0.16$ for narrative writing task and $p=0.27$ for expository writing task) and concluded that when children were directed to write quickly there would be a decline in the legibility. Thus our result in line with this study indicated that handwriting legibility and speed don't follow a parallel course.

If there is any gender and grade related difference in letter reversals shown by the students?

Our study provided the evidence that boys showed more Letter Reversals as compared to girls. Grade first students produced reversal during near-point and far-point copying task. Second grade students frequently reversed dictated letters and third grade students produced reversal during dictation and letter composition tasks. While the students of other grades demonstrated comparatively less reversals. Our result was supported by Jean-Paul Fischer [16] who did a study on mirror among typically developing children (age range between 4-7 years old) and found that during the initial grade students showed reversals when copying and at the age of 6-7 children showed mirror writing from memory and dictation.

What is the effect of pencil grip on handwriting speed and legibility?

Result of One-way ANOVA showed the significant impact of pencil grip on word and letter legibility and speed score. Our study provided the evidence that there was significant decrease in Letter-word legibility and speed score for the students who used atypical grasp (Four Finger and Crossed Thumb grip) (Figure 1).

Figure 1. *Letter-word legibility and Speed score for the students using different pencil grasp.*

Our result was supported by Schwellnus et al. [17], they did a study to assess the effect of pencil grasp on the speed and legibility of handwriting in Grade 4 children and found that The quality of the handwriting decreased after the 10-minute

copy task; however, there was no difference in the quality or speed scores among the different pencil grasps before and after the copy task. And the study of Susan M. Koziatek et al. [18] showed that there was no difference in the legibility among the students using different pencil grasp, but the speeds of the students obtained were slower than previously published fourth-grade speeds. Within the study we also found that the quality and handwriting speed of the boys using the different grips was lower as compared to girls. Thus, indicating that girls are likely to be able to use any grip style with little effect on legibility. This result is supported by Farris K [19] who assessed the relationship between muscle activation and handwriting quality with different grip styles and found that males' legibility scores dropped more, with little effect on legibility of females using different grip style.

Limitations

First limitation was that convenience sampling was used within the study and all the students were from the same geographic area; thus, the scope of the study was limited primarily to the population of one area. Secondly, the students were not completing Evaluation Tool of Children's Handwriting-Manuscript (ETCH-M) in their classrooms but the students were invited to another room in the school so that other students could not be disturbed. So student sensitivity to testing separately could increase the students' anxiety when completing the questionnaire and might have influenced the result.

Conclusion

Within the study, we found that 34% of schoolchildren had Handwriting difficulties as measured by the Handwriting proficiency screening questionnaire. Our study concluded that Handwriting of the girls was more legible as compared to the boys. Girls were faster writer than the boys. For Girls, the tempo of change in handwriting speed was transitory from grade to grade as compared to the boys. When Handwriting performance were analysed according to the grades study showed handwriting speed and legibility improves from grade to grade. J, K, N, P, S, Z, j, z, b, c, q, i, t, d, l, p, s were most commonly reversed letters, which improves with increase in age and grade. Our study also concluded that with increase in student's handwriting speed leads to corresponding decline in the legibility. Static grip and dynamic tripod grip appeared to be the most common pencil grips used by the children. There was significant difference in the quality or speed scores among the students using different pencil grasps. Girls are likely to be able to use any grip style with little effect on legibility as compared to boys. Thus school authorities should carry out children's screening for handwriting performance on regular basis so that handwriting issues can be solved as early as possible.

Future Recommendations

Several recommendations for future research can be identified from the findings of our study. Future studies could focus on assessing the Handwriting performance from more than one school of the different geographic area this will provide a better representation of the population. It may also be beneficial to find the differences in handwriting performance among the right-handed and left-handed students. Other areas to consider exploring would be, assessing the handwriting performance among the students in urban and rural areas.

Ethical Clearance

Verbal consent and written consent were taken from each child's parents/guardians who participated in the study.

Conflicts of Interest

The authors report no conflicts of interest in this work.

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