



An Investigation Into Attention Deficit Hyperactivity Disorder-Diagnosed Elementary Students' Cursive Handwriting Skills *

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Abstract

Using a general survey model, this descriptive and quantitative study aims to describe the writing skills of primary school students who have been diagnosed with attention deficit and hyperactivity disorder [ADHD]. The study sample consisted of 230 primary school students who had been diagnosed with ADHD; their test scores were analysed. Our study attempts to determine whether the sub-factors legibility, fluency, and passing the writing on the surface of the paper differed according to medicine consumption, grade level, and gender; we also try to identify problems in these students' cursive handwriting. Using a rubric developed by the researchers, it was found that the scores ADHD-diagnosed students received in legibility and fluency depended on whether they had taken their medicine and on their grade level; however, there were no significant differences in passing the writing on the surface of the paper. On the basis of gender, there were significant differences in the sub-factors legibility, fluency, and passing the writing on the surface of the paper: female students scored higher. In addition to that on examining students' note-books in terms of shaping the letters, such mistakes as failure to make the connections between letters, inadequate pencil pressure, failure to follow the lines, tendency to use manuscript handwriting and problems of fatigue were found at all grade levels.

Keywords

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Introduction

Many attention deficit hyperactivity disorder-diagnosed children encounter problems in social and academic life. Not yet fully understood by society, Attention Deficit Hyperactivity Disorder [ADHD] is among the most serious problems of our time; it requires the conscious action of educators, parents, and every individual who encounters ADHD-diagnosed children. According to Ercan (2013, p. 19), "Attention deficit and hyperactivity disorder [ADHD] is a disease with high frequency of approximately 5-7%."

Ünal, Öktem, Çengel, Kültür, Topçu, and Yalnızoğlu (2004) describe the diagnosis and types of ADHD as follows:

ADHD is a developmental disorder in childhood period. It is listed under the heading of "attention deficit and disruptive behaviour disorder in Diagnostic and Statistical Manual of Mental Disorders [DSM] IV. It has three types: the type in which lack of attention is prominent, the type in which hyperactivity and impulsivity are prominent and a mixed type in which symptoms from both groups are available (p. 160).

Primary school is the period at which the most prominent problems related to a diagnosis of ADHD arise. Children with ADHD are expected to have problems writing. According to Sürücü (2003, p. 8), "Of all the academic skill, writing is the one in which children with ADHD have the most difficulty. They have bad, disorganised and illegible handwriting." Racine, Majnemer, Shevell, and Snider (2008) find that "children with ADHD mostly cannot read their own messy handwriting, they do not take efficient notes, their homework is full of mistakes and they are not accepted in group work due to their bad writing"; these are all important academic performance problems among children.

Capodiecici, Lachina, and Cornoldi (2018, p. 42) consider handwriting only formally by excluding the properties related to expression and writing, and they call attention to the fact that there are several dimensions needing emphasis. They describe dimensions such as fluency in letter generation, speed and indecisiveness in the proportion of letters. Fluency is very important in maintaining the writing and in the transfer of knowledge. On the other hand, speed is also important since it influences performance in in-class activities and it is also necessary in activities such as writing down the things on the board, taking notes and dictation during classes. Therefore, students' ability to act with their peers in handwriting is very important for children having the problem of attention because they tend to go out of action. In a study aiming to determine the predictors of the handwriting performance of students diagnosed to have ADHD, Brossard Racine, Majnemer, Shevell, Snider, and Belanger (2011) applied manuscript handwriting evaluation instrument, movement measurement battery and visual-motor developmental test to forty students who had ADHD at age eight. The findings they obtained showed that there were problems in handwriting performance in terms of speed and fluency.

The results obtained by Shen, Lee, and Chen (2012) -who analysed the handwriting performance of children with ADHD - demonstrated that the handwriting of children with ADHD in the experimental group was more illegible and that those children spent more time on the paper. The scores received by children with ADHD were compared with the scores of the control group in terms of hand-eye coordination and visual-motor integration, and consequently it was found that motor skills and visual-motor integration were associated with fluency but that they were not associated with writing time. Palacio, De Oliveira, Ameiro, and Casella (2016) were concerned with measuring the motor skills and school performance of children who were diagnosed to have ADHD. The results showed that there were not correlations between motor skills and school performance in the experimental group but that there were statistically significant differences between manual skills and writing performance in the control group. A meta-analysis study on the formal dimension of the handwriting of children with ADHD reports that the handwriting of such students is less legible and that they are slow in writing (Graham, Fishman, Reid, & Hebert, 2016, p. 85).

Studies (Litton, 2003; Zapparoli, 2009) emphasise that ADHD stems from a neurophysiological problem in the prefrontal lobe, and that non-hyperactive students who suffer from attention deficit disorder are more successful than those who are hyperactive. Cognitive states accompanying ADHD also have a negative effect on writing. Research has shown that inattention is often associated with difficulty in reading and writing exercises (Litton, 2003; Zapparoli, 2009). Besides, motor coordination disorders and visual perception problems are common examples of comorbidity in children with ADHD. In this case, pencil control is influenced negatively, impeding writing functions (Çakmakçı, 2012). Hyperactivity is the most common form of motor disorder, and it is mentioned along with lack of attention, reflex and automatic behaviours, and motor activity difficulty (Whirter & Acar, 2000).

An examination of writing teaching practices in Turkey demonstrates that, in the 2017-2018 academic year, cursive writing was abandoned in favour of manuscript writing. For many years, students have failed to adequately achieve standards of quality writing in Turkish education system; children with ADHD encounter even more specific problems in writing. ADHD-diagnosed children should be considered from a different perspective when approaching problems encountered in implementation; teaching strategies to support these children must be put forward.

This study is important as it provides teachers with examples of writing deficiencies among students facing both local and universal problems associated with ADHD. This study is important in that it provides teachers with examples in an issue where education is integrated with local and universal problems. Considering that the number of studies concerning the handwriting of ADHD-diagnosed children is limited, our study—the first in Turkey—sheds light on educators and parents.

This study aims to describe the cursive writing skills of attention deficit hyperactivity disorder-diagnosed elementary school students, and seeks answers to the following questions:

1. Using sub-scales of cursive handwriting legibility, fluency and passing the writing on the surface of the paper, what scores are ADHD-diagnosed elementary school students receiving?
2. Do the test scores of ADHD-diagnosed elementary school students based on sub-scales of cursive handwriting legibility, fluency and passing the writing on the surface of the paper differ depending on whether or not they take medicine?
3. Do the test-scores of ADHD-diagnosed elementary school students based on sub-scales of cursive handwriting legibility, fluency and passing the writing on the surface of the paper differ according to gender?
4. Do the test-scores of ADHD-diagnosed elementary school students based on sub-scales of cursive handwriting legibility, fluency and passing the writing on the surface of the paper differ according to grade level?
5. What problems do ADHD-diagnosed elementary school students commonly encounter in their cursive handwriting?

Method

Research Design

Studies are divided into two as quantitative studies and qualitative studies according to the philosophy they are based on and the perspective they adopt. This study uses quantitative research method requiring collecting quantitative data and analysing them. In such studies, researchers aim to make generalisations, make predictions and to describe the causal relationships. (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, & Demirel, 2016). This study aims to describe attention deficit hyperactivity disorder-diagnosed elementary school students' cursive handwriting skills; it is a descriptive study and uses a general survey method. According to Karasar (2000), the survey method is a study approach that aims to describe a situation that exists in the past or the present. This method makes it possible to conduct a study without compromising natural conditions in the process of

investigation and without changing the investigation environment. This study uses a rubric developed by researchers to describe different aspects of ADHD students' cursive handwriting; students' notebooks were put through document analysis to detect mistakes.

Study Group

The cities included in the research were chosen through convenience sampling. Care was taken to have provinces (Izmir, Istanbul, Ankara, Mersin, Gaziantep, Van, Ordu) to represent each of the seven geographical regions and to have schools and students that were convenient and reachable in terms of cost in those cities. Thus, the cities of Izmir, Istanbul, Ankara, Mersin, Gaziantep, Van and Ordu were chosen for the scope of the research. Convenience sampling is based on elements which are available and which are fast and easy to reach. As is apparent, convenience sampling is the method of a researcher's orienting towards the elements easiest to reach to form their sample from the target population, and the great majority of the studies in the literature prefer that method (Baltacı, 2018, p. 259) Although convenience and cost are taken into consideration in this method, it is also very important when it is necessary to choose the situations in which the maximum information is obtained. Information about the students and samples of cursive handwriting were reached by means of easily accessible schools and teachers working in those schools.

The study group comprised 230 ADHD-diagnosed elementary school students; 98 (43%) of the children were girls, and 132 (57%) were boys. Of the students attending a public school, 50 (22%) were first graders, 67 (29%) were second graders, 65 (28%) were third graders, and 48 (31%) were fourth graders. A total of 104 (45%) of them were on medication, while the remaining 126 (55%) were not.

Data Collection Tools

An "Cursive Handwriting Evaluation Rubric" was developed to collect data on ADHD-diagnosed students' cursive handwriting. Seven domain experts and a measurement and evaluation expert were consulted at the rubric development stage. Accordingly, experts were asked to evaluate each item, labelling it as "Necessary" if they were capable of measuring the specified properties, "Useful but Inadequate" if relevant but in need regulation or modification, or as "Unnecessary" if it did not represent the specified property.

Content validity rates (CVR) and content validity indices (CVI) were calculated for the 20 items in a rubric based on eight expert opinions. The final shape was given to the form according to the content validity rates/indices criteria using a technique developed by Lawshe (1975). Content validity indices are true for the sub-factors; they were obtained for each sub-factor by taking sub-factor items into consideration. If 50% of the experts believe that an item is "necessary," $CVR=0$; if more than 50% believe it is "necessary," $CVR>0$; and if more than 50% do not think it is "necessary," $CVR<0$. If CVR has zero or a negative value, these items are eliminated first. In items with positive CVR values, their significance is tested by using statistical criteria. The significance of items having positive CVR values is tested using statistical criterion. The minimum values (content validity criteria) of CVRs were tabulated by Veneziano and Hooper (1997). Accordingly, the minimum values for the number of experts also mean the statistical significance of an item. Eight experts found the minimum value (content validity criterion) to be 0.78 in this study. Content validity index (CVI) is found by using the items' total CVO averages to be included in the final form and are significant at the levels of $\alpha=0.05$. If a property is to be measured by more than one factor, CVI should be determined for each factor. CVI values are true for sub-factors and they were calculated for each by taking all sub-factor items into consideration. Thus, content validity rates, content validity criterion, and content validity indices for each item are shown in Table 1.

Table 1. Content Validity Rates for Cursive Handwriting Rubric

Cursive handwriting rubric	Content validity rates(CVR)	Cursive handwriting rubric	Content validity rates
M1	0.50	M11	0.75
M2	1.00	M12	0.75
M3	1.00	M13	0.75
M4	0.50	M14	1.00
M5	1.00	M15	1.00
M6	1.00	M16	1.00
M7	1.00	M17	1.00
M8	1.00	M18	0.25
M9	1.00	M19	0.50
M10	1.00	M20	0.75

Number of experts: 8 CVR= 0.78 CVI=1.00

As evident in Table 1, more than half of the experts believed it was “necessary,” since $CVR > 0$; the significance of items with positive CVR values were tested using statistical criteria. Accordingly, it was found that items 1, 4, 11, 12, 13, 18, 19 and 20 were neither appropriate nor adequate criteria for the scale. A content validity index was calculated again after some items were corrected (4, 11, 12, 18, 20) or removed (1, 13, 19) from the test, and the value was found to be 1.00. Upon examining the final form’s content validity index, we found that $CVI > 0.78$; therefore, the scale is statistically significant and has a high content validity index. Accordingly, the 20 items available in the rubric for collecting data on ADHD-diagnosed children’s cursive handwriting were reduced to 16 due to expert opinion; these items were then divided into three factors, namely: legibility, fluency, and passing the writing on the surface of the paper. In the factor of legibility, we considered sub-factors including the ability to connect letters, write them in the proper direction, draw their anatomy with the proper size, adjust the space between them, and make an accurate slope. In the factor of fluency, we considered sub-factors such as being able to write the letters without lifting hands, adjusting pencil pressure, achieving harmonious continuity in cursive writing, and the ability to follow the lines. Finally, in terms of passing the writing on the surface of the paper we considered sub-factors such as knowledge of where to write letters in one’s notebook, spelling and punctuation rules, proper use of a guiding line, writing letters and numbers with identical visual symbols using similar lines, effective eraser use, and the ability to use manuscript basic letters instead of cursive letters. This form also included personal information such as students’ grade levels, school, gender, and if they took medication. Analyses were conducted using 200 randomly chosen words from ADHD diagnosed children’s cursive handwriting notebooks. These evaluations were made according to the rubric created by two researchers with cursive handwriting experience. Cohen’s Kappa coefficient was calculated to determine the agreement between the two researchers’ evaluations to determine whether the evaluations were reliable. Thus, the agreement coefficient was $K = 0.78$ ($p < 0.00 < 0.79$). If Kappa coefficient is between 0.40 and 0.59, agreement is reasonable; if it is between 0.60 and 0.79, agreement is significant, and when larger than 0.80, agreement is perfect (Landis & Koch, 1977). For a significant agreement, Kappa statistics should not fall below 0.60 or above 0.70. Accordingly, this study’s results indicate a significant agreement between raters. The results evidence for the reliability of measurement results.

Student scores in sub-factors including cursive handwriting legibility, fluency and passing the writing on the surface of the paper were evaluated using a 10-point scoring system; if skills related to these sub-factors were not found in student notebooks, the alternative “it was not observed” was recorded. Appendix 1 provides the cursive handwriting evaluation rubric that we used to evaluate ADHD-diagnosed children.

Data Analysis

The normal distribution of the sub-scales of legibility, fluency and passing the writing on the surface of the paper of the data coming from the rubric for assessing the cursive handwriting of the 1st-4th graders who were diagnosed to have ADHD and the homogeneity of variances were tested statistically. We statistically tested the normal data distribution and homogeneity of variances of sub-factors including legibility, fluency and spelling of the rubric for evaluating first to fourth grade ADHD-diagnosed students. Whether or not data collected from groups had normal distribution was tested with skewness and kurtosis coefficients, and a Kolmogorov-Smirnov test; homogeneity of variances, on the other hand, was tested with Levene’s Test of Equality of Error Variances. The data we collected do not have normal distribution and variances are not homogeneous since the p values obtained from Kolmogorov-Smirnov test and Levene’s test were smaller than 0.05 and skewness and kurtosis coefficients were not within a desired range (-1, +1 range). Since the data did not reach the parametric test conditions, we used non-parametric statistics. The Mann-Whitney U test was used to determine whether the scores obtained from two unrelated samples differed, and a Kruskal-Wallis H-Test was used to determine whether the averages of two or more than two unrelated samples differed significantly. Additionally, the size of effect was also calculated to compare the power of relations between variables, and the eta square values of 0.10, 0.30 and 0.50 were interpreted as small, medium and big (large) effects, respectively (Cohen, 1992, 1988, as cited in Field, 2005). The data were analysed using the SPSS 23.0 package program. Bonferroni correction was made to control type 1 errors. Bonferroni correction is found with the formula significance level/ the number of groups (Vialatte & Cichocki, 2008). In this study, Bonferroni correction was found to be $0.05/0=0.025$ when the number of groups was two and 0.012 when the number of groups was four. Thus, significance level used to test the differences between groups was found as mentioned above depending on the number of groups. A total of 200 words were analysed in each students’ notebook; problems in students’ handwriting were described qualitatively. Due to rules of ethics, students’ names were kept confidential and forms were completed using codes for each student; codes such as K1, K2...K230 were used in the data analysis for participants. The qualitative data from notebook analysis are shown comparatively in table 5 in codes and categories.

Results

Results of the descriptive statistics for legibility, fluency and passing the writing on the surface of the paper sub-factors of the rubric for evaluating ADHD students' cursive handwriting are shown in Table 2.

Table 2. Descriptive Statistics Results for Cursive Handwriting

Cursive handwriting evaluation rubric	Number of students (N)	Minimum score (Min)	Maximum score (Max)	Arithmetic averages (\bar{X})	Standard deviations (Sd)
Legibility	230	6.00	57.00	26.60	13.48
Fluency	230	4.00	40.00	24.44	8.30
Passing the writing on the surface of the paper	230	8.00	62.00	46.29	9.48

Table 2 shows us that the maximum scores in the cursive handwriting rubric sub-factors of legibility, fluency, and passing the writing on the surface of the paper are 57, 40, and 62 respectively; the average scores students received from these sub-factors were 26.60, 24.44, and 46.29. As we examined these findings we found that ADHD-diagnosed primary school students performed at a medium level in terms of legibility and fluency, though they performed much better in passing the writing on the surface of the paper.

A Mann-Whitney U Test was used to determine whether the scores ADHD students received in legibility, fluency, and passing the writing on the surface of the paper sub-factors in the rubric for evaluating their handwriting differed according to whether they took medicine. The results are shown in Table 3.

Table 3. Mann-Whitney U Test Results for First to Fourth Grade Students' Evaluation of Cursive Handwriting According to Medicine Consumption

Sub-factors	Whether they take medicine	n	Mean rank	Rank Totals	U	p	r (size of effect)
Legibility	Yes	104	132.19	13747.50	4816.50	0.00*	0.23
	No	126	101.73	12817.50			
Fluency	Yes	104	126.88	13196.00	5368.00	0.018*	0.16
	No	126	106.10	13369.00			
Passing the writing on the surface of the paper	Yes	104	120.34	12515.50	6048.50	0.32	0.07
	No	126	111.50	14049.50			

* $p < 0,025$

According to Table 3, the scores ADHD-diagnosed primary school students received in legibility ($U=4816.50$; $p < 0.025$) and fluency ($U=5368.00$; $p < 0.025$) sub-factors differed according to whether they had taken medicine; however, they did not significantly differ in the sub-factor of passing the writing on the surface of the paper ($U=6048,00$; $p < 0.025$). Upon looking at mean ranks we found that students who took their medicine had higher score averages than those who do not in sub-factors of legibility and fluency. Additionally, our examination of effect size yielded a value of $r=0.23$ and $r=0.16$ for legibility and fluency respectively. The values demonstrate that differences between students' scores in legibility and fluency are not significant.

A Mann-Whitney U Test was used to determine whether ADHD-diagnosed students' scores in the legibility, fluency and passing the writing on the surface of the paper sub-factors of the handwriting rubric differed according to gender; the results are displayed in Table 4.

Table 4. Mann-Whitney U Test Results for First to Fourth Grade Students' Evaluation of Cursive Handwriting According to Gender

Sub-factors	Gender	n	Mean rank	Rank total	U	p	r (size of effect)
Legibility	Girls	98	138.03	13526.50	4260.50	0.00	0.29
	Boys	132	98.78	13038.50			
Fluency	Girls	98	139.04	13626.00	4161.00	0.00	0.30
	Boys	132	98.02	12939.00			
Passing the writing on the surface of the paper	Girls	98	135.92	13320.00	4467.00	0.00	0.26
	Boys	132	100.34	13245.00			

*p<0,025

Accordingly, the scores of ADHD-diagnosed primary school students received in sub-factors including legibility (U=4260.50; p<0.025), fluency (U=4161.00; p<0.025) and passing the writing on the surface of the paper (U=4467.00; p<0.025) differed according to gender. On examining mean rank, we found that girls had higher average scores than boys in legibility, fluency, and passing the writing on the surface of the paper. Upon examining the size of effect, a value of r=0.29 was found for legibility, r=0.30 for fluency, and r=0.26 for passing the writing on the surface of the paper. These values demonstrate that there is no significant difference between boys' and girls' scores in legibility, fluency or passing the writing on the surface of the paper.

A Mann-Whitney U Test was used to determine whether ADHD-diagnosed student scores in the sub-factors of legibility, fluency and passing the writing on the surface of the paper in the handwriting evaluation rubric differed according to grade levels; the results are shown in Table 5.

Table 5. Kruskal-Wallis H-Test Results for First and Fourth Grade Students' Evaluation of Cursive Handwriting According to Grade Level

Sub-factors	Grade levels	n	Mean rank	sd	X ²	p	Significant difference	r (Size of effect)
Legibility	1	50	136.80	3	27.84	0.00*	2-3,1-3, 1-4, 2-4	0,28, 0,28, 0,40, 0,40
	2	67	137.87					
	3	65	100.24					
	4	48	82.75					
Fluency	1	50	114.90	3	19.66	0.00*	2-3, 2-4	0,28, 0,41
	2	67	142.60					
	3	65	107.55					
	4	48	89.07					
Passing the writing on the surface of the paper	1	50	93.37	3	9.35	0.02		
	2	67	130.84					
	3	65	118.77					
	4	48	112.72					

*p<0.0122

We can see in Table 5 that the scores ADHD-diagnosed primary school students received in sub-factors including legibility ($\chi^2(3) = 27.84$; $p < 0.0122$) and fluency ($\chi^2(3) = 19.66$; $p < 0.0122$) differed according to grade level; however, their scores did not significantly differ with regards to passing the writing on the surface of the paper ($\chi^2(3) = 9.35$; $p > 0.0122$). Our examination of mean rank revealed that the highest scores in legibility, fluency and passing the writing on the surface of the paper were achieved by second graders; this score was followed by first, third, and fourth grade students respectively in the sub-factor of passing the writing on the surface of the paper.

A Mann-Whitney U Test was administered to determine which groups had differences, and we analysed the sources. Accordingly, we found that first and second grade students had higher average scores than third or fourth grade students in the legibility sub-factor and that second grade students had higher score averages than third or fourth grade students in fluency: here, the differences were significant. Additionally, a Kruskal Wallis Test was used to calculate the size of effects for both groups. Thus, in the legibility sub-factor, $r_{2-3} = 0.28$, $r_{1-3} = 0.28$, $r_{1-4} = 0.40$, $r_{2-4} = 0.40$; $r_{2-3} = 0.28$, $r_{2-4} = 0.41$. This situation indicates that there were no significant differences between second and third grade students and second and fourth grade students in legibility and fluency; there were, however, significant differences between first and fourth graders and second and fourth graders in the same sub-factors. We can also see that writing-related problems grow parallel with rising grade levels. Figure 1 shows changes in legibility and fluency scores according to grade level.

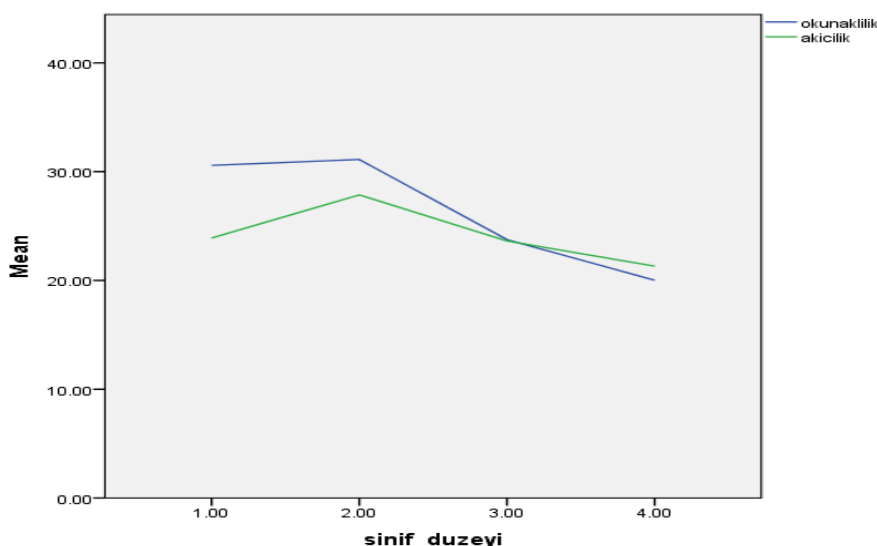


Figure 1. Changes in Legibility and Fluency Scores According to Grade Level

The descriptive records noted by the raters in the rubric were qualitatively analysed. The problems related to writing are shown in Table 6.

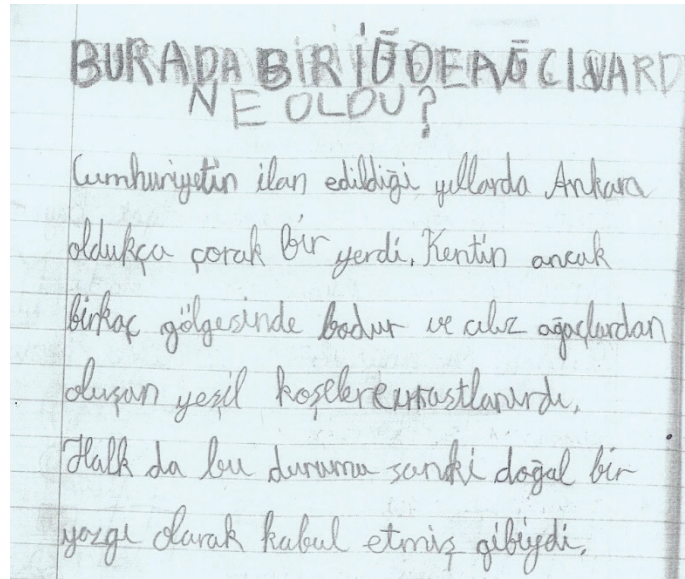
Table 6. Problems with ADHD-Diagnosed Primary School Students' Cursive Handwriting

1 st graders	2 nd graders	3 rd graders	4 th graders
Shaping the letters incorrectly	Shaping the letters incorrectly	Shaping the letters incorrectly	Shaping the letters incorrectly
Not being able shape letters such as "r, n, s, t, m", or skipping a letter	Not being able to make the lines one after another in the letters m, n, ü, c, g		

Table 6. Continued

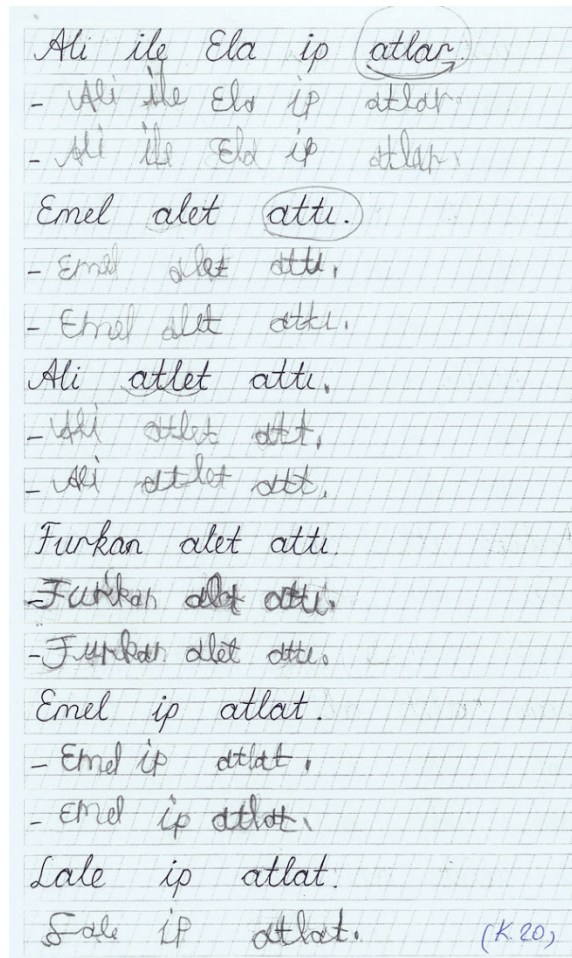
1st graders	2nd graders	3rd graders	4th graders
Connections between letters	Connections between letters	Connections between letters	Connections between letters
Not making looped lines	Not making looped lines		
Not being able to adjust the space between letters			
	Skipping a letter/syllable, writing a word incorrectly	Skipping a letter/syllable, writing a word incorrectly	Skipping a letter/syllable, writing a word incorrectly
Problems in controlling the pencil	Problems in controlling the pencil	Problems in using capital letters-lower case letters	
Extreme pencil pressure			
Insufficient pencil pressure	Insufficient pencil pressure	Insufficient pencil pressure	Insufficient pencil pressure
Not using guiding lines			
Not being able to follow the lines	Not being able to follow the lines	Not being able to follow the lines	Not being able to follow the lines
Making dots very big or forgetting them	Making dots very big or forgetting them	Forgetting to put full stops	Forgetting to put full stops
Writing small	Minimised writing	Minimised writing	Minimised writing
Writing big			Writing big
Forgetting dots	Lack in punctuation marks	Lack in spelling and punctuation marks	Lack in spelling and punctuation marks
No being able to write italic letters	No being able to write italic letters	No being able to write italic letters	No being able to write italic letters
Using manuscript writing symbols	Using manuscript writing symbols	Using manuscript writing symbols	Using manuscript writing symbols
Writing numbers in reverse	Errors in using the eraser		
	Space between letters and words	Space between letters and words	
Tiredness	Tiredness	Tiredness	Tiredness

Table 6 shows us that students often make mistakes shaping letters. Students at every grade level make mistakes in connecting letters, which is a basic component of cursive handwriting. One emerging code shows us that students who cannot make connections between letters have a tendency to use manuscript handwriting. Yet another remarkable finding was that students of all grade levels apply insufficient pressure to the pencil. Failure to follow lines and tiredness were among the codes common to all students. By analysing the codes, we found that ADHD-diagnosed students could not fulfil the basic necessities. Examples of handwriting problems are provided below.



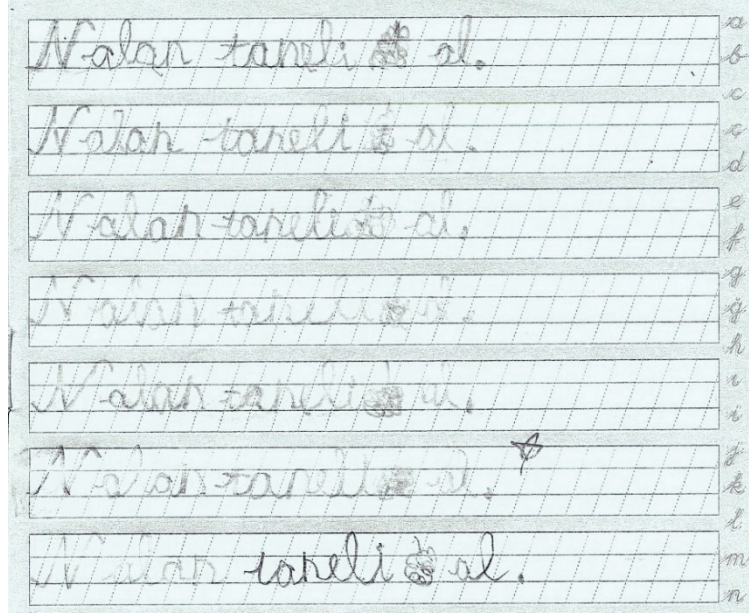
Picture 1. Tendency to Use Manuscript Handwriting (K89)

On examining the picture 1 closely, it is clear that the heading is written in manuscript handwriting although the whole page is in the form of cursive handwriting. Here, it can be seen that the student used capital letters in the form of manuscript writing and that he/she could not write cursive handwriting.



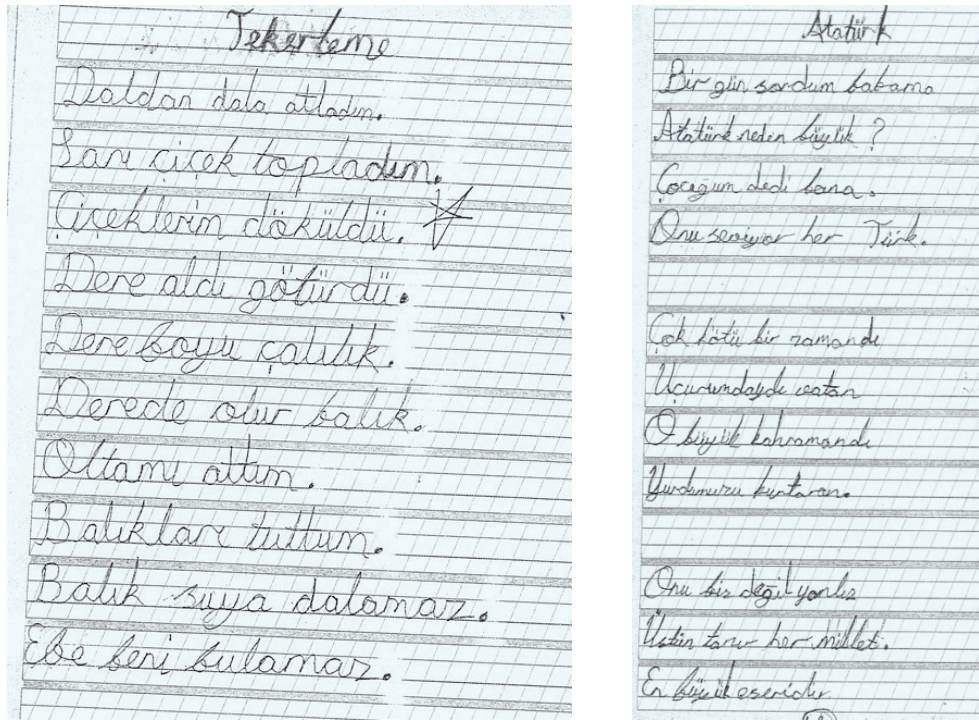
Picture 2. Failure to Follow The Lines and Failure to Make the Shapes and Connections of the Letters (K20)

It is clear from the picture 2 that the student has written the teacher's sample sentences again by looking at them. It is evident that the letters are not written at appropriate intervals although a striped note book is used and that the student has difficulty in following the lines. It is also apparent that the letters are not shaped correctly and that the connections between letters have so many curls that they damage legibility.



Picture 3. Insufficient Pencil Pressure (K1)

It is evident that the parts which are pale in the picture 3 are illegible due to insufficient pencil pressure.



Picture 4. Minimised writing (K117)

The two pages in picture 4 were taken from a student's note book. Although it is a notebook with stripes, shrinking in letters is apparent.

Discussion, Conclusion and Suggestions

This study, which aimed to investigate ADHD-diagnosed elementary school students' cursive handwriting skills, revealed that student performance in sub-factors including legibility and fluency were medium according to the cursive handwriting evaluation rubric. However, these students performed better in passing the writing on the surface of the paper than they did in legibility or fluency. Zapparoli's (2009) research, which analyses ADHD children's written expression skills with and without reading difficulty, supports our findings. This study makes it clear that attention deficit is associated with writing and reading difficulty.

In relation to another research sub-problem, this study reveals that ADHD student scores in rubric sub-factors including legibility and fluency differed depending on whether they took medicine; those who took medicine tended to score higher. However, medicine did not appear to be a significant factor in passing the writing on the surface of the paper scores. Apart from this, as we examine the size of effect, we found no significant difference between students' legibility or fluency scores. This situation may be interpreted this way: while medicine improves the appearance of handwriting, students require guided activities to write accurately and beautifully. In primary school, passing the writing on the surface of the paper cannot be corrected on their own; rather, they must be corrected through appropriate exercises. Therefore, taking medicine does not appear to affect students' writing skills. Rosenblum, Epztein, and Josman's (2008) study on ADHD-diagnosed children also considers medicine as a factor. Their findings show that children with ADHD writing faster than children without ADHD; however, no significant differences in writing speed were detected between the periods when they took medicine and the periods when they did not. Another important finding of the study is that the handwriting of children diagnosed with ADHD shows no remarkable difference in terms of letter position adjustment, legibility, swollen letters, stacked letters, or unrecognisable letters between the periods when they used medicine and those in which they did not. This finding supports the result that taking medicine does not cause considerable differences in effect size.

In relation to another sub-problem of our research, we found that scores received by ADHD children in sub-factors including legibility, fluency, and passing the writing on the surface of the paper differed according to gender: girls tended to score higher. Examining the size of effect, however, the differences between boys' and girls' legibility, fluency and passing the writing on the surface of the paper scores were small. Stephen Peter's (1993) study suggested that male students with attention deficit disorder and especially the students with attention deficit accompanied by hyperactivity disorder were restricted in written expression and writing skills. The tests administered in the study showed that male ADHD students were incompetent in graphical expression skills and copying content. Another gender-related study conducted in Turkey is Sezer's (2015), here, Sezer found that in a group of 100 students with ADHD (50% of whom were girls and 50% were boys), boys had significantly lower scores than girls. This indicates that gender differences favour girls. Research conducted on the basis of gender in the literature shows that female students with ADHD have a disadvantage over male students.

In addition to gender, another variable is grade level. While this study found that ADHD-diagnosed primary school students' scores in legibility and fluency in the rubric for evaluating cursive handwriting skills changed according to grade level, there was no significant difference in the sub-factor passing the writing on the surface of the paper. On examining mean rank we found that second grade students received the highest scores in legibility, fluency and passing the writing on the surface of the paper, followed by first, third and fourth grade students, respectively. This may be attributed to the fact that second grade is the grade at which students can focus on writing while their personal traits have yet to appear. Writing personalisation begins in the second half of third grade, and unless writing exercises are completed, one's writing will enter a process of deformation. Therefore, first grade is the grade in which students first learn to meet sub-factors in writing criteria such as legibility and fluency;

in the third and fourth grades, students' writing is influenced by the process of deformation. The fact that third, fourth, and first grade students become susceptible to spelling mistakes can be explained since spelling mistakes increase due to rising grade level. Examining the differences between groups, we found that first and second grade students had significantly higher average scores than third and fourth grade students in legibility and that second grade students had significantly higher score averages than third and fourth grade students in fluency. While these results show that the differences between second and third grade students and the differences between second and fourth grade students in legibility and fluency were not significant, the differences between the first and fourth grade students and between second and fourth grade students were significant in the same sub-factors. This can be explained since writing-related problems grow as grade level increases. Akyol (2006) brings attention to the fact that expectations increase in parallel to grade level and that children will have difficulty in meeting expectations unless they gain the basic skills related to writing (such as fluency, speed, etc.). In order to elaborate his argument, he classifies the problems encountered in the process of writing under different headings: writing illegibly due to failure in concentrating, making several simple mistakes, problems in placing writing on the surface of the paper and not being able to write the letters appropriately due to problems in diving into stages, not being able to write the letters due to motor problems, and failure to attain fluency.

As we analysed students' writing problems, another sub-problem in this study, we found that students of all grade levels frequently shaped letters incorrectly. Connections between letters, another important element to cursive handwriting, were also found to be done incorrectly at every grade level. Students who are unable to make necessary connections tend to revert to manuscript handwriting; such is one of the codes that emerged in this study. Another remarkable finding was that pencil pressure was insufficient at all grade levels. An examination of common codes showed that failure to follow the lines, tiredness at the end of the page and deformation in handwriting stemming from tiredness were also major problems. On examining the codes suggested, we found that ADHD students could not fulfil basic writing requirements. Relevant studies bring attention to problems students have in relation to motor control.

In her MA thesis, entitled "First and Second Graders' Spelling Mistakes and Teachers' Views on the Mistakes," Koçak Demir (2003) concludes that primary education school teachers were aware that students' spelling mistakes stemmed from factors including sight, hearing, and learning disorders but that they were not informed regarding spelling. Upon analysing participant-produced writing, researchers found that students made too many mistakes according to the criteria and that mistakes transferred to grades: unless these mistakes are corrected they become compounded, which was an important finding. Spelling mistakes include mistakes in letter usage and mistakes related to the shapes of letters (Taşkaya & Yetkin, 2015).

Petrauskas' (2013) doctoral dissertation, it was determined that for ADHD children, writing quality increases when writing speed decreases. No differences were found between the experimental group and the control group in terms of fluency or pencil pressure. This finding contradicts our finding that pencil pressure was low at all grade levels. However, many studies draw attention to ADHD students' problems related to motor control. Litton's (2003) doctoral dissertation compares students between the ages of seven and twelve, 19 of whom had ADHD and 19 of whom did not have ADHD, in terms of motor control. Children with ADHD exhibited inferior motor control compared to children without ADHD. Another study conducted by Shen et al. (2012) found that the legibility level of ADHD-diagnosed children's handwriting was low and that the children wrote more slowly. This situation demonstrates that motor skills and visual-motor coordination are factors influencing handwriting legibility. Brossard Racine et al. (2011) found that insufficient legibility and low speed of writing were the most pressing problems encountered in ADHD-diagnosed children's handwriting.

Based on the findings obtained in this study, ADHD-diagnosed students could be studied from the perspective of speed and legibility. Comparative studies that direct ADHD children to write on a keyboard and by hand could also be performed to gauge the writing development of ADHD-diagnosed children. Longitudinal studies can analyse the writing development of primary school ADHD students in detail throughout their primary education. The effects of medicine on writing skills could also be investigated, and handwriting improvement programmes could be provided to students with and without ADHD. Teachers could be trained, and ADHD students and non-ADHD students' writing skills could be studied comparatively.

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Appendix 1. Rubric for Evaluating Cursive Handwriting

Code for the unit of analysis: K

Grade level: _____ Age : _____

School/ City: _____

Gender **Girl () Boy ()**

Whether he/she takes medicine: **Yes () / No ()**

THIS EVALUATION WAS MADE THROUGH WORDS

EVALUATION: Give a point between 1 and 10

POINT(S)

LEGIBILITY

Being able to make connections between letters

1 2 3 4 5 6 7 8 9 10
[Not observed]

Being able to write the direction of letters correctly

1 2 3 4 5 6 7 8 9 10
[]

Being able to draw the anatomy of letters correctly

1 2 3 4 5 6 7 8 9 10
[Not observed]

Being able to draw the size of letters adequately

1 2 3 4 5 6 7 8 9 10
[Not observed]

Being able to adjust the space between letters adequately

1 2 3 4 5 6 7 8 9 10
[Not observed]

Being able to make the curve in letters

1 2 3 4 5 6 7 8 9 10
[Not observed]

FLUENCY

Being able to write without lifting his/her hand within a letter

1 2 3 4 5 6 7 8 9 10
[Not observed]

Being able to adjust pencil pressure

1 2 3 4 5 6 7 8 9 10
[Not observed]

Having harmonious continuity in cursive handwriting

1 2 3 4 5 6 7 8 9 10
[Not observed]

Being able to follow the lines in writing

1 2 3 4 5 6 7 8 9 10
[Not observed]

PASSING THE WRITING ON THE SURFACE OF THE PAPER

Knowing where to write the letters in his/her notebook

1 2 3 4 5 6 7 8 9 10
[Not observed]

Using punctuation rules correctly

1 2 3 4 5 6 7 8 9 10
[Not observed]

Being able to use the guiding lines adequately

1 2 3 4 5 6 7 8 9 10
[Not observed]

Writing visual symbols, similar letters and numbers with similar lines

1 2 3 4 5 6 7 8 9 10
[Not observed]

Being able to use the eraser effectively

1 2 3 4 5 6 7 8 9 10
[Not observed]

Using manuscript writing symbols instead of cursive letters

1 2 3 4 5 6 7 8 9 10
[Not observed]

Analyst's views: