

Identifying the factors that contribute to hand writing problems experienced by students at a higher education institution in South Africa

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ABSTRACT

The assessment of the handwriting of students in Higher Education Institutions has received little attention. This study therefore determined the handwriting problems reported by 300 students at the University of the Witwatersrand when writing examinations. These students were also screened for factors related to dysfunction in their hand writing using a short screening copying task and analysed for its quality and errors. A Handwriting Assessment Checklist was used to assess various factors related to handwriting such as posture and pen grasp as observed by two trained occupational therapists.

Students appear to have little understanding of their handwriting problems as those reporting that handwriting affected their ability to finish examinations were not those identified as having dysfunctional handwriting. Speed of writing was significantly affected by poor positioning of the paper ($p \leq 0.03$), following of text being copied related to motor dysgraphia and oculomotor function ($p \leq 0.00$), maintenance of grasp on the pen ($p \leq 0.04$) and accuracy when copying ($p \leq 0.02$). Legibility in contrast was significantly worse due to holding the pen too close to the tip ($p \leq 0.00$), pressure used when writing ($p \leq 0.01$), deterioration or change in the writing ($p \leq 0.01$) errors related to missing words ($p \leq 0.02$) and spelling mistakes ($p \leq 0.003$). These factors may be related to motor and/or dyslexic dysgraphia.

These factors should therefore be considered with a speed and legibility score when assessing whether a student presents with a "real" handwriting problem so further appropriate assessment can determine accommodations the student needs to allow them to complete their examinations.

Key words: Legibility, Speed of writing, Motor and dyslexic dysgraphia

INTRODUCTION

Occupational therapists are involved in the remediation of handwriting in children, and a large evidence base which has established practice standards for the assessment of handwriting problems has been developed¹. In contrast, the assessment of handwriting skills in adults, including students in Higher Education Institutions (HEI) has received little attention.

The skill of producing fast and legible handwriting in higher education is important as most assessments of academic ability worldwide are still based on written timed examinations and poor handwriting may result in a student under-achieving academically². Connelly, Dockrell and Barnett³ showed that undergraduate students are significantly constrained in written examinations when they struggle with the speed and legibility of writing. This is a distraction as they use working memory to concentrate on producing writing and cannot focus their full attention on answering the examination questions. The ability to produce letters automatically has been found to be the single best predictor of the quality and length of written composition even in post school years⁴.

At the University of the Witwatersrand students are required to write examinations lasting between two to four hours twice a year. The Occupational Therapy Department has been involved in the assessment of students in conjunction with the Disability Unit, including students who present with handwriting problems and who request extra time for examinations to compensate for these problems. These students report problems with finishing examinations, complaints about the legibility of their handwriting as well as constraints such as pain in their hands when writing. Approximately 35 to 40 students apply for extra time concessions annually due to problems related to their handwriting, with four or five of these students applying to type their examinations⁵.

Therefore determining what constitutes dysfunctional handwriting in terms of normal speed and acceptable legibility or dysgraphia in a South African sample of students, as well as the other factors that may affect students' handwriting is important for informing decisions made regarding the extent to which they should be accommodated in terms of extra time for examinations. By establishing which factors can be used to identify significant handwriting

dysfunction, students can be screened and referred appropriately for further assessment.

LITERATURE REVIEW

Summers & Catarro⁶ researched handwriting in a sample of Australian undergraduate students excluding those with any identified problems. They focussed on the importance of handwriting in written examinations, with the need for speed and an acceptable level of legibility in communicating answers within a set time and considered a number of factors including age, gender, pain, fatigue and pencil grasp in relation to writing fluency. They found that all the students reported aching in their hands and /or upper limbs, when writing two and three hour examinations, while 50% reported cramping and one third reported a high level of pain. Pain was associated with fatigue, which 74% of students reported affected their writing speed as well as the quality of their writing. Fatigue resulted in 45% of students having to stop and rest during examinations. Nine percent of students were identified as having to stop and rest in a short three-minute handwriting assessment because of pain.

No significant difference was found by Summers and Catarro⁶ for speed related to gender, writing style and handedness in the undergraduate students⁶ even though females and right-handers in another study were found to write faster than left-handers⁷. In addition Summers and Catarro reported that pen grasp with a lateral as opposed to a dynamic grasp was not associated with slower writing in examinations⁶. Small differences in the average speed of writing for students between 17 to 25 years have been found, however. In a short handwriting assessment when copying a sentence, on average, the speed is 26 words per minute (wpm) when asked to write neatly and 36 wpm when asked to write as fast as possible⁸.

In their study Summers and Catarro⁶ found legibility was not associated with writing speed but that the assessment of legibility was problematic in that it is based on the judgement of assessors. The use of scales ranging from three to seven points or counting of unreadable words are the suggested methods of assessing legibility but no studies on scores for the legibility of hand writing in higher education could be found⁸.



The handwriting problems described above appear to have been exacerbated by the introduction of technology which means that a large number of individuals are using keyboards and tablets for everyday note taking and assignments⁹, so students no longer get daily practice in writing and writing motor fluency. Thus writing endurance is decreased, evidenced by discomfort or pain in the hand, and this may lead to legibility and speed being affected which further affects the students' ability to complete their timed examinations. Legibility and presentation associated with poor handwriting have been shown to contribute to differences in examination marks, although the number of words written in an examination is not necessarily directly linked to how fast a student can write, but to other cognitive abilities as well. If the answer is incomplete because they write too slowly or the writing is illegible this will affect the outcome⁶.

Even when offered the opportunity to type their answers in examinations rather than write them a recent study in the United Kingdom has shown that the majority of students, still opt for writing with only 10% choosing to type⁹. This choice was made even though it was shown that these same students could type faster than they could write. Most students cited their own lack of practice in using computers in composing answers in examinations and fear of technology failures as the reasons for continuing to write their examinations. Therefore extra time to write is still one of the options offered when a student has dysfunctional hand writing⁹.

A number of other factors related to dysfunctional speed and quality of handwriting has been reported in studies on children's writing. According to Pollock et al¹⁰, children's posture as well as the amount of force they use to hold a pencil and "press" on the paper plays an important role in writing skill. Selin¹¹ also described various components of pencil grasp related to the positioning of the upper limbs, wrist, fingers and thumb which can be considered dysfunctional when writing. Kulp and Schmidt¹² also emphasise the importance of efficient oculomotor skills in writing examinations for aspects such as reading, copying and the visual motor integration.

When these factors are considered together and an individual's handwriting is found to be compromised in relation to speed or legibility it can be considered "dysgraphic"¹³. Symptoms of dysgraphia include an inefficient pen grasp, fatigue and cramping after a short time when writing, accuracy in copying and spelling, poor letter formation, type of writing and reading aloud while copying¹⁴. Dysgraphia is characterised as a learning disability by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)¹⁵ but there is some controversy about whether this involves only the motor skill needed to write or other aspects described by Berninger and Wolf¹⁶ which include letter recognition or orthographic skills and spelling as well as finger sequencing. Deuel¹⁷ indicated that the different components could be considered as three different types of dysgraphia and related to the motor, dyslexic and spatial aspects of writing all of which result in different handwriting dysfunction.

The aim of this study was therefore to use a short handwriting screening assessment to determine the factors related to handwriting dysfunction and dysgraphia in undergraduate students at the University of the Witwatersrand. The speed and legibility of the students handwriting was determined and the problems that students report with their handwriting when writing examinations were also investigated.

OBJECTIVES

- ❖ To determine a cut off point at which writing can be considered dysfunctional in terms of speed and legibility for students at the University of the Witwatersrand.
- ❖ To determine the problems with handwriting during examinations reported by students at the University of the Witwatersrand.
- ❖ To establish observable factors related to motor, praxis and sensory-perceptual performance skills associated with handwriting dysfunction in relation to slow and illegible handwriting
- ❖ To establish which components of handwriting are associated with slow and/or illegible handwriting.

METHODOLOGY

A descriptive cross sectional study was used appropriate for a once off screening of students' handwriting problems. The factors assessed related to their ability to copy a passage and the speed and legibility of their handwriting. Convenience sampling was used to select 300 undergraduate students from the entire student population in the five different faculties at the University of the Witwatersrand. Students with known physical disabilities affecting their handwriting were excluded. The sample size was based on 10 participants per item on the checklist used to assess observable factors and their writing.

A survey questionnaire was used to establish the students' demographics in terms of age, and any handwriting problems they had experienced during long examinations. The close-ended questions determined whether the student could finish writing their examinations without pain or discomfort in their hands, and reported experience of postural and visual strain when writing examinations of two to four hours in length.

In order to screen their handwriting for problems a copying exercise, consisting of a 114 word paragraph from a university level text book was used. Students were also asked to write the alphabet repeatedly for 1 minute to assess their ability to form each letter neatly for orthographic-motor integration¹⁸. These items could be completed within the time of the nine minutes recommended O'Mahony, Dempsey and Killeen¹⁹, for an adult handwriting test, if endurance and fatigue were to be assessed.

Students were asked to note the time it took to complete the copied passage using a timer on an i-Pad and writing speed was determined by the time it took them to copy the 114 words. This eliminated the time consuming exercise of counting the number of words that were written as required in other assessments. Legibility was established by calculating the percentage of unreadable words⁸. The writing content was also analysed for spelling mistakes, omitted letters, words and lines of text, as well as the misuse of capital letters, punctuation and any other corrections on a scale of 1-3.

The passage chosen for the screening assessment did not contain words which are considered as course specific jargon. The use of this paragraph, unlike other assessments that only required repeated copying of a simple sentence which can be remembered, negating the need to read while copying, required the student to follow the text as they copied it. This was important as examinations also require near point reading of complex information. Copying was, therefore, used to observe the students' ability to follow the text in the passage, and how their ability to find their place in a question paper might impact on their writing speed.

To identify the problems observed in the students' handwriting a Writing Analysis Checklist was developed based on criteria described by Selin¹¹ and Pollock et al¹⁰. Items on the checklist included aspects of motor and praxis skills related to proximal stability and posture in sitting, the need to position the eyes and hands correctly for the task, as well as bilateral function or stabilisation of the paper with the non-preferred hand. Pen grasp, accuracy in copying and spelling, letter formation and type of writing were also observed while the students completed the writing test¹⁴. Sensory perceptual skills observed included the organisation of workspace and the positioning of the paper being written on and the one being copied from. Fatigue and pain were noted by observing repositioning of the pen in the hand and shaking the hand while writing⁶. All items were scored according to what literature describes as 1 = functional, 2 = mild dysfunction and 3 = dysfunctional^{10,11}. Students were observed by two qualified occupational therapists who had been trained in the use of the Writing Analysis Checklist (inter-rater reliability 0.79) while they completed the writing task.

Once ethical clearance had been obtained from the Human Research Ethics Committee and all stakeholders at the University of the Witwatersrand, the students were asked to sign informed consent forms before being assessed in the second half of the year after the June tests. This time period was chosen, so that even if they were in first year they would have had a chance

to experience any handwriting problems related to writing long examinations at a university level. The test was carried out at tables of the correct height for writing and students were provided with examination pads with faint rule lines to write on and standard ball point pens. The students were able to use their own pens if they so wished.

Demographic data were analysed using descriptive statistics. The mean for speed and legibility of the students handwriting were determined and a cut-off was set at the 10th percentile (-1.5 SD) as there is evidence that this score separates individuals with disabilities from the normal population²⁰. Speed and legibility scores for each item on the Writing Analysis Checklist were analysed and the scores of students who scored 2 or 3 indicating dysfunction were compared to those who scored 1 and were considered to be functional writers. Student t tests were used to establish if there were significant differences on each item of the checklist between the students who scored 1 as compared to those who scored 2 or 3. The level of significance in the study was set at $p < 0.05$.

RESULTS

Speed and Legibility Scores

The mean score for speed of writing on the screening assessment was 22.85 wpm. There were wide variations in both the speed and legibility scores with a mean score for legibility being 15.37% or between 17 to 18 unreadable words in the 114 word copied passage. The cut-off scores which identify handwriting as dysfunctional for speed and legibility were set at the 10th percentile (Table 1). There was a low correlation between legibility and speed of writing ($r = 0.26$).

Demographics and reported problems with handwriting

The students' ages ranged from 17 to 25 years with the majority falling into the 19-21 year age group (Table 2).

Students who reported that they had been diagnosed previously with a learning disability formed 5.7 % of the sample, with

more students reporting they had problems with the legibility of their writing than any other handwriting problem affecting their ability to write examinations. Other problems included writing speed, pain and vision and not being able to hold the pen properly (Table 3).

The correlations between students' reported problems and the scores on the screening assessment for speed and legibility were poor $r = 0.15$ ($p > 0.05$) and $r = -0.25$ ($p \leq 0.01$). The legibility scores of 25 (8%) students who did not report legibility as a problem fell below the 10th percentile as they had more than 30.7% of unreadable words. They were unaware that the legibility of their writing was a problem. A similar finding was found for the 28 (9.3%) of students whose writing was slower than 17.58 wpm, with only four of them identifying they had a problem with writing speed.

Just over half of the students reported that endurance in terms of finishing examinations without pain or discomfort in their hands was a problem, with only 32% of the students reporting that they had never experienced discomfort and pain. Of the 68% of the students who reported discomfort, 28% had little discomfort, 33% had moderate discomfort and 28% had high discomfort or little pain with a score of four or below on a pain scale of zero to ten. Seventy five percent of the students reported that they had stopped and shaken their hands during the writing of examinations. Only 9.35% reported moderate pain of between five and six on the pain scale and 1.33% high pain levels. There was a moderate correlation between reported pain and fatigue and needing to stop and shake the hand during examinations ($r=0.43$, $p \leq 0.001$).

Writing Analysis Checklist

Table 4 on page 6 illustrates the percentage of students with factors which could be considered dysfunctional, scoring 2 or 3 on the Writing Analysis Checklist.

The speed and the legibility scores of students with observed dysfunction were compared to those who were considered functional in terms of their workspace organisation, pen grasp, ability to copy from written text and aspects of their handwriting.

Table 1: Overall speed and legibility scores for the entire sample

Speed	Range	Mean (SD)	Cut-off scores at the 10th percentile indicating dysfunction
Words per minute	13.35 – 34.10	22.85 (4.15)	17.58
Legibility	Range	Mean(SD)	
Unreadable words	0 % - 74.50%	15.37% (12.98)	30.7%

Table 2: Demographics of the sample (n=300)

Age	Range	Percentage (n)	Percentage (n)	Percentage (n)		
	17-25 years	17-18 years	19-21 years	22-25 years		
			75%	13.33%		
Percentage (n)			Percentage (n)			
Gender			Female			
Male			61.33%			
Writing Hand			Left			
Right			10.66%			
89.34%						

Table 3: Reported problems with handwriting that affect ability to write examinations

	Legibility	Speed	Pain	Vision	Other
	Percentage (n)	Percentage (n)	Percentage (n)	Percentage (n)	Percentage (n)
Handwriting problems	8.66% (26)	1.33% (4)	1.33% (4)	0.66% (2)	2.33% (7)
Untidy illegible writing			Not finishing exams		
Handwriting affecting examinations	2.66% (8)			4.33% (13)	



Table 4: Observable behaviours related to handwriting for which significant differences were found between functional and dysfunctional students

	Percentage presenting with dysfunction Percentage (n)	Observation of student				P	
		Speed-Words per minute Mean (SD)		P	Legibility Percentage unreadable words Mean (SD)		
		Functional	Dysfunctional		Functional	Dysfunctional	
Position of paper in relation to the student	25.0% (75)	22.55 (4.12)	23.70 (4.19)	0.03*	15.95 (13.24)	13.65 (12.25)	0.18
Hesitates and takes time to find place in text	10.6% (32)	23.29 (4.04)	19.38 (3.58)	0.00*	14.92 (12.31)	16.29 (17.08)	0.58
Repositions pen or stops and shake hand	6.0% (27)	23.01 (4.22)	21.52 (3.71)	0.02*	16.29 (13.17)	11.11 (12.01)	0.04*
Fingers too close to paper	34.0% (102)	22.98 (4.15)	22.78 (4.25)	0.70	13.24 (11.43)	17.70 (15.42)	0.00*
Reads aloud to self as writes	1.66% (5)	22.98 (4.15)	17.14 (2.11)	0.01*	13.54 (13.03)	20.52 (17.75)	0.38
Observations of handwriting							
Heavy pressure on paper	20.0% (60)	22.83 (3.99)	23.19 (4.28)	0.57	14.01 (11.54)	19.08 (15.66)	0.01*
Deterioration in writing- in 5 minutes	12.33% (37)	22.51 (3.99)	23.47 (3.46)	0.19	14.64 (12.86)	19.95 (14.37)	0.02*
Change in writing	5.0% (15)	22.83	23.19	0.87	14.64	16.01	0.01*
Missing or added words	12.6% (38)	22.67 (4.11)	22.77 (4.28)	0.94	15.10 (13.08)	23.67 (14.68)	0.02*
More than 3 spelling mistakes	14.66% (44)	22.80 (4.19)	22.85 (4.20)	0.94	12.08 (11.18)	22.84 (14.40)	0.00*
More than 3 corrections	11.00% (33)	23.32 (4.66)	21.23 (3.38)	0.02*	16.35 (14.45)	17.78 (13.36)	0.61
Significance set $p \leq 0.05$							

Speed of writing, recorded as words per minute (wpm), was significantly slower in students who positioned their paper to the side rather than in front of them (1.15 wpm; $p = 0.03$), took time to find their place in the text they were copying from (3.91 wpm; $p=0.001$), repositioned the pen in their hand or stopped to shake their hand in the five minutes writing period (3.91 wpm; $p = 0.00$), and read aloud or mouthed the words while copying (5.84 wpm; $p=0.01$). Those that made more than three corrections when copying (2.09 wpm; $p = 0.02$) also had significantly slower writing speed.

Legibility, measured by the percentage of unreadable words, was significantly worse when holding the pen too close to the tip (4.46%; $p = 0.001$), and when pressing very hard on the paper while writing so that the impression of the writing could be seen on the next page, (5.07%; $p=0.01$). Legibility was also worse when there was a deterioration in the quality of the writing (5.31%; $p = 0.01$) with writing no longer on the lines, the size of the writing changing and letter formation being more compromised and a change in writing style in terms of printed and cursive writing, by the end of the copied passage (1.37%; $p = 0.01$). Inaccuracies in copying reflected by missing words (8.57%; $p = 0.02$) and three or more spelling mistakes (10.76%; $p = 0.00$) were also related to significantly worse legibility. Students who repositioned the pen in their hands had significantly more legible writing (5.18%; $p=0.04$).

Factors that have been described as dysfunctional in handwriting such as flexed posture, resting both forearms on the table, tight pen grasp with hyperextension of the distal interphalangeal (DIP) joint of the index/middle finger and flexion of the interphalangeal (IP) thumb joint to 90°, indicating poor stability in the hand¹¹ or some joint laxity²¹, were seen in 50% of students when writing. Thus these factors cannot be considered as dysfunctional when assessing students' writing, as the majority of students use these positions of the trunk and hand and components of pen grasp when writing.

The majority of the students (84.3 %) used efficient tripod grasp or quadrupod grasp against the ring finger with an open or narrowed web space. A low correlation ($r=0.30$; $p=0.01$) was found between the efficiency of pen grasp and writing speed. Hand dominance had no effect on the speed and legibility of writing.

Printed writing was used by the nearly half of the sample of students (44.66%) and this type of writing was significantly more legible ($p=0.001$) than either mixed cursive-printed writing used by 36.66% of students or the cursive writing used by 18.66% of the student sample. Cursive writing was however found to be significantly faster than printing ($p = 0.001$).

DISCUSSION

The results for the mean score of 22.85 wpm found in this study

indicate that when copying a longer passage with complex words, students write more slowly than when repeatedly copying a simple sentence used in the other assessments which report a speed of between 26–36 wpm. It is impractical to assess the handwriting of students in the examination situation, and although it is accepted that the use of short handwriting assessments is not ideal, they are used to identifying problems which may impact on writing in examinations. The use of the longer copied paragraph in this study which required reading of more complex words does reflect the motor, praxis and sensory-perceptual performance skills used in examinations better than copying a simple sentence. The slower mean writing speed therefore probably reflects this and provides a cut-off that can be applied when screening students in the South African context. The cut-off for the score for legibility can possibly be applied in the same way, although no other scores for legibility in this type of population could be found and the inter-rater reliability of the legibility score still needs to be established. There was no association between speed and legibility in this study which was also found in previous studies on children^{22,23}.

The most common handwriting problems reported by students were illegibility, pain and slow speed of writing. More students reported slow writing and an inability to finish examinations as an issue, with only one student reporting that his marks were affected because the examiner could not read his paper. There was, however, a very low and negative correlation between the students who reported problems and those who scored poorly for legibility and speed on the screening assessment. It appears that students' ability to judge their own handwriting quality in terms of speed and legibility is poor and this is of concern as these students may be compromised in their ability to complete examinations or in the outcome of the examination if their papers cannot be read.

The number of students reporting discomfort and pain during the writing of long two to four hour examinations differs from the findings of Summers and Catarro⁶ as fewer students in this sample, 68% compared to the 100% in the Australian study reported discomfort in their hand and 9% compared to 33% experienced high levels of pain when writing examinations. It is possible that students in South Africa may still practise writing more often than those in a developed country like Australia, as there has been less access to laptops and tablets in lectures, and most students do still take some handwritten notes. This means that their writing endurance may be greater than that of the Australian students, leading to less discomfort and pain when writing for long periods.

When the Writing Analysis Checklist was analysed it was clear that speed and legibility alone could not be considered when screening for handwriting problems. A number of other factors were found that differentiate dysfunctional writing, and these need to be considered as indicative of problems that need further assessment. It was clear that some factors that have been associated with handwriting problems had no significant effect in this study. These include a flexed trunk posture when writing and resting on both forearms on the table which cannot be considered dysfunctional in this population and have no effect on legibility and speed when writing. While poor posture has been linked to writing dysfunction in children¹⁰, there was no relationship between speed and legibility and a flexed supported posture in this study. It would appear that in adults this does not influence writing as much.

The same applies for a tight pen grasp with DIP hyperextension of the index finger/middle finger where the thumb IP joint is flexed to 90°, with no association between a tight pen grasp and fatigue, pain, speed or legibility of writing, even though both of these have been identified as part of an ineffective pen grasp related to poor stability in the hand¹¹, and joint laxity by²¹. Schneck²⁴ proposed that the increased pressure on the pencil shaft is used to gain sensory feedback is responsible for excessive range seen in the finger and thumb joints, and a number of authors have indicated this type of pen grasp persists due to a lack of adequate early training in pencil use^{25,26}.

Factors identified on the Writing Analysis Checklist associated with significantly reduced writing speed were the sensory-percep-

tual skills related to the organisation of the work space with the positioning of the paper to the side of their preferred hand. Those who took time to find their place in the text they were copying also took significantly longer to write the passage. Those who used a finger to follow the text compensated for this problem, and although slower than those who could read quickly, this was not significantly so. This is possibly related to oculomotor function or visual perceptual skills including figure ground perception and all students who stared for a few seconds at the passage they were copying or followed the text with their finger require further assessment for visual functioning²⁷. Reading the text aloud while copying is described as a sign of dysgraphia¹⁴ and not unexpectedly significantly slowed down the writing speed of the students who did this.

Those who made three or more corrections when copying had significantly slower writing speed, while legibility was significantly compromised in those with three or more spelling mistakes. These factors are possible identifiers for dyslexic dysgraphia when recognition and accurate spelling, along with the ability to write legibly are affected¹⁷. Students should be referred for further assessment for dyslexia in such cases.

The repositioning of the pen in the hand or stopping to shake the hand in the first five minutes of writing, while slowing the students down, did result in significantly more legible writing. Other factors, associated with motor and praxis performance skills and motor dysgraphia¹⁷ were found to significantly affect legibility. These included holding the pen too close to the tip, pressing very hard on the paper while writing, and deterioration in the writing or change in the type of writing from print to cursive by the end of the copied passage. All of these factors have been related to dyspraxia associated with poor fine motor control as described by Smits Engelsman and Van Galen²⁸ and legibility problems in writing neatly.

Unlike the results of the Summers and Catarro's study⁶, significant differences were found between the types of writing students use. The majority of students used printing, which was more legible than either mixed print and cursive or cursive writing. As with their findings, there was no relationship between handedness and speed and legibility.

This study identified a cut-off for both speed and legibility which can be applied when screening undergraduate students with handwriting problems. It is clear however that the screening should include the assessment of factors that significantly affect the speed and legibility of handwriting so that problems identified can be further assessed using appropriate standardised tests.

CONCLUSION

Only a small percentage of students reported problems with their handwriting and their handwriting affecting their ability to finish examinations. However the students who identified their writing as illegible were not those who scored poorly on the Writing Analysis Checklist legibility score indicating that students themselves are often unaware of what constitutes a problem with legibility. It is suggested that students in higher education may need to be screened to determine if they have a handwriting problem as they are not aware of the problems they have and how this may affect their academic achievement.

In this study factors which significantly affect speed like visually tracking text, reading aloud as well as the number of corrections made while copying and repositioning of the pen in the hand related to dysfunctional handwriting have been identified that can be used to establish if students present with a "real" handwriting problem. Factors which significantly affect legibility were identified as the pressure used on the paper when writing, deterioration or change in writing after five minutes and the number of missing words, and spelling mistakes. Further, appropriate assessment can determine the amount of extra time needed or whether the students need to change their writing to printing to make it more legible.

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