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The possibilities of ICT use for compensation of difficulties with reading in pupils with dyslexia

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Abstract

The paper presents the possibilities of using ICT for compensation of difficulties with reading in pupils with dyslexia and during re-education. These include mainly text editing, use of different fonts, special educational software, improvement of teaching process, use of multimedia etc. Furthermore the paper presents the results of a research project focusing on a comparison of reading speed and efficiency (the number of mistakes) when using the standard writing fonts and OpenDyslexic font (a font created for dyslectics). The data has been collected using a standardized reading test, the results have been statistically processed.

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1. Introduction

The article treats the possibilities of ICT use for the work with dyslectic pupils, focusing on text editing and adjustment of the visual aspects of the text to the needs of the pupils.

British Dyslexia Association (BDA) approved the following definition: „Dyslexia is a specific learning difficulty that mainly affects the development of literacy and language related skills. It is likely to be present at birth and to be life-long in its effects. It is characterised by difficulties with phonological processing, rapid naming, working

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memory, processing speed, and the automatic development of skills that may not match up to an individual's other cognitive abilities. It tends to be resistant to conventional teaching methods, but its effect can be mitigated by appropriately specific intervention, including the application of information technology and supportive counselling (British Dyslexia Association, 2007). Dyslexia is the most frequent specific learning difficulty and it complicates all activities dependent on reading performance, consequently it has an essential impact on the child's success at school. The difficulty affects the basic variables of reading performance – speed, correctness, reading technique and comprehension. Moreover, it causes difficulties with orientation in the text (repetition of the beginning of words, skipping of lines etc.) and text reproduction. Incorrect reading or even mangling of words result in the so-called specific errors including static inversions (e.g. confusing letters of similar shapes such as b-d-p, a-o-e, m-n, l-k-h etc.), kinetic inversions (e.g. mixing of syllables), skipping or adding of extra syllables, words or sentences, inappropriate use of diacritics or guessing of word endings. However, the occurrence of specific errors is highly language specific both in terms of frequency and the presence of the various types (e.g. diacritics, specific pronunciation errors etc.). A specific error which inevitably occurs in all languages is the confusion of letters of similar shapes (see the presentation of the research project below).

Dyslectic children have general skills disproportionately better than reading skills. Furthermore, they are worse at reading in comparison with their peers. Pupils with dyslexia, a difficulty affecting the acquisition of reading skills, achieve lower levels of reading efficiency although they are provided with normal educational guidance and have adequate intelligence.

One of the biological causes of dyslexia is a dysfunction of the magnocellular system. Dyslectic people have on average 30 % less magnocellular neurons compared with the control group. The system plays an essential role in reading, being responsible for the gathering of visual data. (Stein, 2003; Stein, Walsh, 1997). It is crucial for eye movements during reading, especially for the quick motion feedback preventing excessive fixation on the word being read. The malfunction of the magnocellular system manifests itself in an impairment of visual perception, leading to chaotic eye movements and consequent difficulties with the identification of letters etc. The effect of the chaotic eye movements is that letters seem to be moving making it impossible for the dyslectic reader to capture them and process their shape and order (e.g. if *c* and *l* come close together they look like *d*) (Zelinková, 2003).

Reading performance of pupils with SLD is affected by a number of factors, such as motivation and interest in reading, didactic procedures or socio-cultural environment, however, the graphic qualities of the text such as font size or line spacing are no less important (Zelinková, 2003). Some research projects (The effect of print size on reading speed in dyslexia., 2005) dealing with the influence of font size on reading speed in dyslectic pupils even assumed that appropriate graphic properties may enable dyslectic pupils to achieve a curve of development comparable with the curve of healthy individuals. Previous research confirmed that difficult visual conditions lower reading performance of dyslectic individuals.

There are a number of studies examining the influence of visual features on the improvement of reading performance of dyslectics. According to Stein (2003) the confusion is greater if font size is small, while bigger font size has a positive effect on reading (Stein, 2003, Stein, Walsh, 1997). A similar study (The Effect of Font Size on Reading Comprehension on Second and Fifth Grade Children: Bigger Is Not Always Better., 2013) dealing with the influence of font size on reading comprehension does not deny the findings, however, it also revealed that font size, line length and spacing etc. have a bearing on the reading performance of younger pupils, while having almost no effect in older pupils. This is connected with the fact that readers gradually develop a skill to decode smaller and smaller print. Nevertheless, it does not explain why dyslectic individuals require bigger font size to improve their reading. Considering the character of dyslexia discussed above, a plausible explanation seems to be that bigger font size creates bigger spaces between adjacent letters, which decreases their clustering and facilitates their identification (DeLamater, 2010).

More factors which have been examined in various studies apart from font size and line spacing include the use of serif/sans-serif typeface, letter spacing or the use of a special font. Research projects focusing on the appropriateness of serif/sans-serif typefaces for reading brought different findings. Some people found that a serif typeface helped them to focus on the current line, while others felt that it complicated the identification of letters. An explanation of the positive effects of sans-serif typeface is that bigger spaces between letters enable faster identification. Another finding in support of the use of sans serif typeface is that the majority of participants in the research prefer sans-serif typeface even if the reading was slower in comparison with serif typeface. (Pijpker, 2013). LDA (Learning

Disabilities Association) states that the use of bigger font size, line spacing or a special font depends on the individual needs of every pupil (Accommodations, Techniques and Aids For Learning., 2014).

British Dyslexia Association recommends appropriate choice of font and background colour, the use of thick paper which is not transparent, the use of suitable font or font size as a prevention of visual stress and a means of facilitating the reading (Dyslexia style guide, 2014).

Hughes and Wilkins (2000) claim that children with reading difficulties are more susceptible to visual stress and graphic aspects of the text influence them heavily. Visual stress manifests itself in unpleasant visual symptoms during reading such as illusionary shapes, movement and colours of the text, broken or blurred print and general visual irritation. Furthermore, it may cause pain in the eyes and head, frequent loss of orientation in the text and worsened comprehension. Readers with dyslexia face more difficult word recognition and in comparison with other readers they are forced to focus more on the print, which makes them more sensitive to all visual aspects of the text that might cause visual stress, such as the contrast of black and white, line spacing, font or quality of the print. This finding led the authors to further examination of the influence of the visual properties of the text on reading in dyslectics. It is the font size and spacing that Hughes and Wilkins (2002) found to be the most important factors. The final part of the study *The Effect of Font Size on Reading Comprehension on Second and Fifth Grade Children: Bigger Is Not Always Better* (2013) revealed that bigger letter spacing and word spacing affect reading even more than font size.

2. The possibilities of ICT use for the compensation of reading difficulties in dyslectic individuals

With respect to the development of Information and Communication Technologies and their integration in all spheres of social life including education, our country places considerable demands on teachers and their pupils in terms of the teaching methods and work with modern technology. It searches for the possibilities to use ICT as a tool enabling the implementation of new educational methods, improvement and modernization of education, finding new possibilities and making the teaching process more efficient (Vzdělání 21, 2014).

ICT is a suitable tool of individualization and satisfaction of the need to adapt the teaching process and methods to the needs of individuals, who are physically, mentally or socially disadvantaged in comparison with the rest of the population, i.e. the individuals with special needs.

The goal of the new progressive teaching method called *interactive teaching* is to offer to students a more amusing and less monotonous form of education, increasing their attention and motivation to learn. An equally important goal is the effort to involve the pupils themselves in the education process, enabling them to actively participate in it and shape it instead of being mere passive listeners (Interaktivní výuka, 2014).

In the course of the last five years, the Interactive Whiteboard (IWB) has become almost a common piece of classroom equipment, replacing the older overhead projectors, video, and TV or data projectors. The advantage of IWB is that it gives the teacher the possibility to create electronic multimedia materials combining photos, pictures, videos and hyperlinks to other sources. Such materials make teaching better arranged, more illustrative, systematic, and attractive and are more efficient in holding the weaker attention of pupils with SLD.

Technology permits teachers to provide materials using different media, webpages, e-mail etc. and to easily adjust them to the varying needs of pupils since it is easy to update and store them or insert references to further materials in any form.

There are a number of online gateways offering teachers further education, inspiration but also vast amounts of quality teaching materials available for free (in the Czech Republic these are created within subsidized projects whose results must be offered for free). IWB enables fast adjustments of the content and graphics of the material (change of font, font size, line spacing, background colour, font colour) according to the needs of individuals with SLD. For instance, it is possible to assign individual work to a group of pupils, asking them to take a test using the poll device enabling to answer questions which appear on the board, which gives us the possibility to provide immediate feedback and work with mistakes before they become fossilized, involving all the students at the same time. Another advantage of electronic materials is that they are not only easy to present but also easily made accessible to the whole class, which makes it possible to actively work with them or use them for practice at home. Moreover, they function as a clear outline of schoolwork for pupils with dyslexia or other learning difficulties.

A suitable complement of IWB is an interactive textbook. Interactive textbooks enable the use of interactive material (pictures, audio, video, animations etc.) in class. The individual subjects include audio and video recordings and references to webpages providing further information on the topic at hand. Furthermore, the subjects are connected by inter-subjects relations, which helps the children realize that it is necessary to combine some pieces of knowledge with others, supplement and connect them instead of separating them (Interaktivní výuka, 2014). For example, the design of reading books maximizes the amount of acquired knowledge and the saves the teacher time since it includes a tool for selection of difficult and less common words, audio versions of the texts, useful hyperlinks (e.g. a map of the place described in the text, encyclopaedic knowledge about the animal or plant mentioned in the text etc.), or questions and tasks to use with the text etc. Interactive textbooks enable the change of font size; however, unlike with e-book readers or tablets it is not possible to adjust line spacing, background, brightness or font.

Furthermore, modern technologies facilitate and seed up the communication between the individual participants in the teaching process (email, webpages, Facebook, e-learning etc.). E-learning is another step forward in the field of self-education (Zounek 2009). In e-learning, ICT are used to prepare courses offering online access to electronic materials and education independent of the school building, self-study, communication with other participants and management of the study). As far as primary education is concerned, it is used rather to provide further training for teachers.

Modern technologies play an important role in the education of pupils with special educational needs as well. Special software designed for children with special educational needs is a very useful didactic tool. Software for pupils with dyslexia or other SLD often focuses on the individual senses – aural and visual perception, orientation in space, it supports attention and development of memory but also helps with re-education in case of problems with specific skills such as arithmetic, writing, acquisition of grammatical rules reading etc. (Zíkl, 2011).

An advantage of ICT use in teaching individuals with special educational needs is the already mentioned individualization enabling the teacher to involve all pupils at the same time despite their differing needs. The children can work independently on materials prepared in advance or in an electronic environment. Another asset is the possibility of compensation in the case of common activities since the software and various devices permit the pupils to eliminate the negative effects of their difficulties (e.g. write essays on a PC, read a book using tablet, which enables graphic adjustments of the text, listen to instructions instead of reading them etc.).

Both the effort to find a supportive tool improving reading capacity and the development and greater accessibility of ICT result in a more frequent use of e-book readers and tablets. These devices enable the reader to change font size, background, brightness, line spacing or typeface, which makes them friendly to dyslectic readers.

The use of special software or audio visual technologies in teaching is attractive and often also amusing. The richness of the accessible technologies permits interactive engagement with the teaching matter using different senses, which facilitates understanding and makes everything easier to remember. Modern technologies and software are useful complements of traditional didactic tools, their function is to motivate the learners, teach them to correct their own mistakes and be more independent.

3. The influence of font on the quality of reading in dyslectics

The aim of our research was to determine the impact of the choice of font on the reading of pupils with specific learning difficulties, i.e. reading speed and error rate in terms of both quality and quantity.

We compared the reading performance of pupils with SLD achieved when using the common sans-serif font Arial and the font Open Dyslectic. The font was created specifically for dyslectics with the goal of eliminate the most frequent difficulties such as confusion of letters of similar shape or letters which are mirror images of one another etc. The author tried to achieve this by introducing minute changes of letter shapes, their inclination or line weight (OpenDyslexic, 2014). The case of *b* and *d* may serve as an example of this. The two letters are identical in shape but one is a mirror image of the other. In the font Open Dyslectic, they have slightly different shapes, line weight of the curve and inclination (see figure 1). The font is not used in the Czech Republic yet, however, there is a Czech version covering the special Czech characters available for free. Foreign studies (Could a simple font help dyslexics read?, 2014) state that the use of Open Dyslectic does not increase reading speed but reduces the occurrence of

specific reading errors. Besides the unique shape of individual letters, individuals with dyslexia view positively the bigger letter spacing and word spacing. The article OpenDyslexic font gains ground with help of Instapaper (2012) explains that better readability of the font moderates the effects of visual stress, which is another positive point.

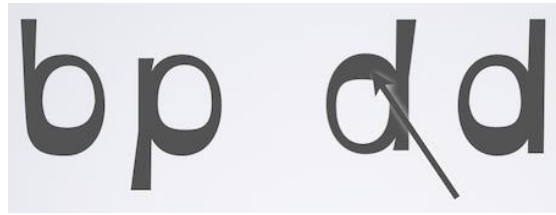


Fig. 1. A sample of Open Dyslexic font (OpenDyslexic, 2014)

3.1. Research objectives and methods

Our objective was to verify whether the use of the specific font affects reading quality in dyslectics in the Czech Republic and whether the font is suitable to be used for re-education and compensation of their problems.

We compared the sans-serif font Open Dyslectic with the commonly used sans-serif font Arial. The text which we chose to collect data is a part of a standardized reading test used to diagnose dyslexia in the Czech Republic (Matějček, 1992). Since the pupils were asked to read the same text repeatedly (in different fonts) we selected an article called “Latyš“, which is a piece of writing in an imaginary language structurally equivalent to Czech (the incidence of consonants/vowels, word length etc.). All the tables with texts in the individual fonts were adjusted according to the norms of the standardized test (the article Latyš) – same text, same number of words per line, font size, line spacing etc. The administration of the individual tests followed the standard procedures of the Reading test (recording of mistakes, instructions etc.). Each pupil read the same text twice in two different fonts, the second reading taking place two weeks after the first. The point of introducing the interval of two weeks was to prevent children from remembering the text as well as from using their intelligence to compensate for their reading difficulties, which is the purpose of texts in an unknown language. In order to maximize objectivity, the pupils were divided into random groups and they read the texts in different orders.

Research sample comprised 150 pupils of fourth and fifth grades from 58 primary schools (75 dyslectic pupils and 75 intact ones, 1-2 pairs from each school). Each pupil with dyslexia was paired with an intact pupil from the same school, class and of the same sex and age. The description of the research sample is given in table 1.

We formulated the following hypotheses:

H1: Dyslectic pupils will read more words per minute with Open Dyslectic than with Arial.

H2: Dyslectic pupils will make fewer mistakes with Open Dyslectic than with Arial.

The test was also administered in the control sample (intact pupils) so that it was possible to compare whether the different fonts have an effect on reading speed and error rate.

Table 1. Description of the research sample

	Dyslectic pupils	Intact pupils
Number of participants (boys/girls)*	75 (49/26)	75 (49/26)
Average age	10,24	10,13
*the ratio of boys/girls corresponds with the higher occurrence of dyslexia in boys		

3.2. Research results

The results showed the expectable difference in reading speed and error rate between dyslectics and intact pupils. Reading speed of pupils with dyslexia is one third lower than reading speed of intact pupils, the difference being more or less constant irrespective of the font used (31,3 % with Open Dyslexic, 32,2 % Arial; Table 2). The difference in error rates is also considerable (84,4 % more mistakes with Open Dyslexic, 75 % more mistakes with Arial; Table 3). Nevertheless, this difference is very marked and it is not statistically significant.

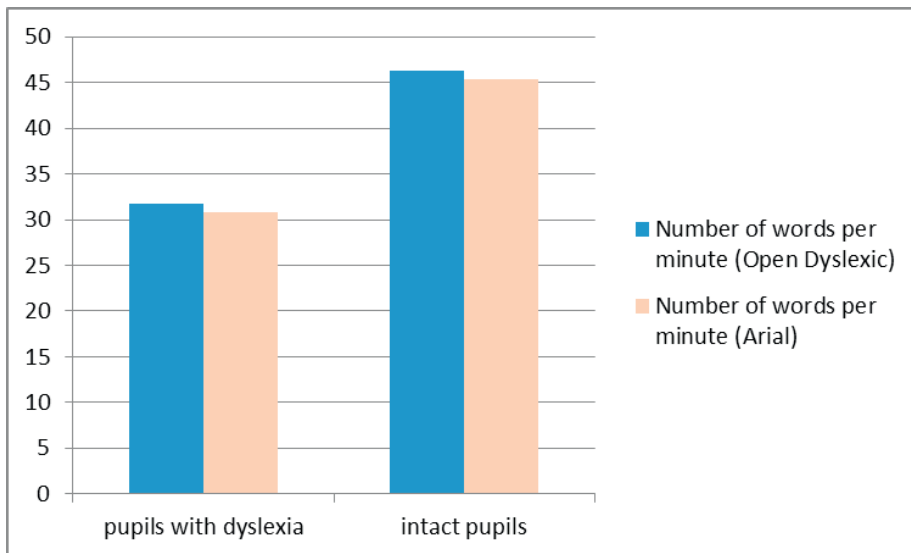
Our main objective was the analysis of the results concerning pupils with dyslexia. As table 2 and graph 1 show, reading speed was approximately constant irrespective of the font, to be precise, when reading the font Open Dyslectic pupils were slightly faster (by a mere one word per minute). Neither the error rate was significantly influenced by the choice of font, which is evident from table 3 and graph 2. When reading Open Dyslectic, pupils made slightly fewer mistakes, however, the difference is minimal and not statistically significant.

Neither hypothesis was confirmed by the research, which suggests that the choice of font has no marked impact on reading speed and error rate.

Table 2. Number of words per minute

	average	standard deviation	median	T-value	Z-value
Dyslectic pupils (Open Dyslexic)	31,8	11	31	0,6238	0,701389
Dyslectic pupils (Arial)	30,8	9,06	30		
Intact pupils (Open Dyslexic)	46,3	12,94	43	0,4157	0,4218
Intact pupils (Arial)	45,4	12,54	43		

The differences in the results in this table are not statistically significant.

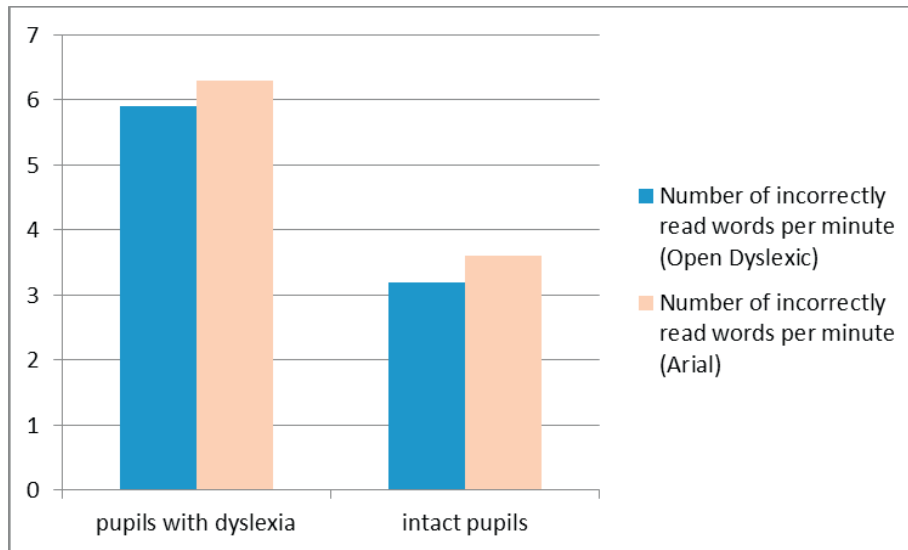


Graph 1. Number of words per minute.

Table 3. Number of incorrectly read words per minute

	average	standard deviation	median	T-value	Z-value
Dyslectic pupils (Open Dyslexic)	5,9	3,48	6	-0,6389	0,727558
Dyslectic pupils (Arial)	6,3	4,29	6		
Intact pupils (Open Dyslexic)	3,2	2,61	3	-0,7626	-0,5718
Intact pupils (Arial)	3,6	3,9	3		

The differences in the results in this table are not statistically significant.



Graph 2. Number of incorrectly read words per minute.

Nevertheless, it is impossible to generalize and state that a different font has no importance since a positive effect might have been present only with some pupils, which is not evident from the overall results. Some of the participants claimed that the text on Open Dyslexic was easier to read, while others had a subjective feeling of worse readability. Some of the pupils may have a better subjective feeling about reading, they may be less tired and more motivated (and able to read longer) without their error rate and reading speed being affected.

Error rates were slightly lower with Open Dyslexic, mainly in pupils which made very frequent mistakes. For example, there were 12 pupils who made 10 or more mistakes with Open Dyslexic but there were 16 such pupils with Arial. These results suggest that the effect of Open Dyslexic might be present mainly in pupils with more serious reading difficulties. However, statistical testing of this requires more data collection and a more detailed analysis.

Furthermore the results might have been affected by different amount of experience with the individual fonts. While children often use Arial, Open Dyslexic was entirely new to them and it is possible that after familiarization with it the results might have been better.

As re-education of pupils with dyslexia should be individualized it is possible to offer a choice and try which font (as well as line spacing font size etc.) is more suitable for each pupil, since there are likely to be significant differences between the individual pupils.

4. Conclusion

To conclude, we may state that the use of the font Open Dyslectic, which was designed specifically for pupils with dyslexia did not lead to any marked improvement of reading speed or error rates in comparison with the commonly used font. Although the comparison shows slightly better results with Open Dyslectic, especially in pupils with serious problems, the font was not proved to be statistically better. On the other hand, a number of pupils claimed that Open Dyslectic was more readable for them, so it is possible that certain individuals might find the font more suitable than common fonts. The use of ICT enables us to make quick and easy adjustments of the texts, permitting the pupils to try different fonts and graphic arrangements and chose the most efficient option.

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