

The evaluation of the achievement of students with dyslexia in the subject of Physics in the Greek educational system

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Abstract

In this paper, we study the evaluation of the achievement of students with dyslexia in Physics in the Greek educational system. The first section of the study includes the aspects of psychology and neuropsychology which describe the symptoms of dyslexia and its possible causes. In the second section of the study, we describe the procedure of the evaluation of the achievement of students with dyslexia in the primary and in the secondary education and more specifically in the subject of Physics. In the third section, we describe our proposal about the criteria the teachers of Physics should apply to the writing of the questions for the tests of Physics so that students with dyslexia do not confront any reading difficulties.

1. Introduction

In Salamanca, 1994, the international organisations and the government representatives from all over the world declared that all students with special educational needs have the right to attend ordinary education [1]. Recently the Council of the European Union (2003) asked the member states of the Union to encourage and support the social integration of children with special needs through appropriate education [2]. In Greece, the Parliament established a new law for the education of children with special educational needs. According to this law, a basic aim of special education is to help these children attend mainstream schools [3]. Children with dyslexia have special educational needs and the evaluation of their achievement in the subject of Physics is a procedure that occurs very often during their education, therefore we studied this theme in order to contribute to the integration of students with dyslexia in the mainstream schools.

2. Developmental dyslexia

Developmental dyslexia (or reading disorder) is defined as a specific impairment in reading abilities. The reading achievement of students with dyslexia falls substantially below the expected for the students' chronological age, intelligence and learning opportunities in general [4] [5]. The oral reading of students with dyslexia is characterised by distortions, substitutions, or omissions. In general oral and silent reading are characterised by slowness and errors in comprehension [5]. According to neuropsychological studies, the phonological hypothesis describes the basic defect in segmenting and manipulating the phonemes of speech. Another hypothesis interprets dyslexia as a multi-system deficit based on incapacity of the brain in performing tasks that require process of brief stimuli in rapid temporal succession [6]. The brain activation patterns of readers with dyslexia showed relative underactivation in posterior regions such as Wernicke's area, the angular gyrus and the striate cortex. On the contrary, the inferior frontal gyrus, which is an anterior region, showed a relative overactivation. The premature reliance on the left hemisphere reading strategies or the later failure to shift from the earlier right hemisphere reading strategies to the left characterise the different types of dyslexia, L-type (Linguistic) and P-type (Perceptual) correspondingly [7]. The L-type dyslexic children are excessively fast readers paying little attention to the meaning. The P-type dyslexic children read word by word because they confront difficulties in decoding the words. According to an investigation the short-term memory storage, the long-term

memory storage and the semantic memory storage of children, ages 8-14, with dyslexia perform specific deficit [8]. Recent analyses support that serial memory and abstract visual-spatial memory performance of students with dyslexia is poorer than that of students without reading disabilities [9].

3. The evaluation of the achievement of students with dyslexia in Greece

3.1. Primary education

Students attend the subject of Physical Science in the last two grades of primary education, 5th and 6th grade. This subject contains basic concepts of the science of Physics. The techniques the teachers use in order to estimate the achievement of these children in the subject of Science are the following [10] a) the oral examination which takes part every day, and the observation of the students' participation in the daily learning process and the other activities of the school, b) the tests-exercises included in the teaching material, c) the homework that every student is obliged to accomplish, d) every other test that the teacher considers necessary to construct, e) the project the students of the last two grades may accomplish in the specific subject. Teachers of primary education evaluate the achievement of students with dyslexia using the above-mentioned techniques.

3.2. Secondary education

The secondary education in Greece includes the High school and the Unified Upper Secondary School (Lyceum), three grades correspondingly. Students attend courses of Physics in the second and third grade of high school. The teachers of Physics use the following techniques in order to evaluate the achievement of the students [11] a) the oral examination, which takes part every day, and the observation of the participation of students in the learning process, b) the short-time written tests, which evaluate the students' assimilation of the daily subject matter, c) the written tests of an hour duration which examine the assimilation of a wider part of the subject matter, d) the daily homework of the students, e) the project the students may choose to accomplish in the specific subject, f) the final written tests which evaluate the students' assimilation of the whole subject matter. As for the evaluation of the achievement of students with dyslexia, the teachers of Physics use the technique of oral examination instead of the written examination [12]. Students with dyslexia have to answer the same questions as the rest of the students, but they give the answers orally to their teacher after the end of the examination.

In the Lyceum, the students attend the subject of Physics in every grade. The teachers of Physics evaluate the achievement of students by using the following techniques [13] a) the observation of the participation of the students in the daily learning process, b) the observation of the interest of the students for the specific subject, c) the written tests of an hour duration which evaluate the students' assimilation of the subject matter, d) the homework and the work the students accomplish in the classroom, e) the project the students may choose to accomplish in the subject of Physics, f) the final written tests which evaluate the students' assimilation of the whole subject matter. The students with dyslexia are not obliged to write the answers of the questions of the written tests and according to the regulation law they may answer orally the questions [14]. In all the above-mentioned written tests, students with dyslexia have to answer the same questions as the rest of the students. We believe that this regulation of the law is insufficient because a) the students with dyslexia feel inconvenient when they answer orally before their examiner, b) the students with dyslexia are isolated from the rest of the students by being evaluated with a different technique, c) the students with dyslexia mainly have difficulties in reading and not so much in writing (see the section about developmental dyslexia). In order to overcome the insufficiency of the regulation we propose the written examination as an alternative technique for the evaluation of the achievement of students with dyslexia who do not have writing problems. However, we believe that the

construction of the written questions of the tests should be done according to specific criteria so that students with dyslexia do not confront any reading difficulties. The definition of these criteria constitutes the third section of our study and it is described in the following paragraphs.

4. Criteria for the construction of the written questions

4.1. Definition of the criteria

In order to define the criteria that should be applied to the writing of the questions we divided the procedure of the writing of the question in three parts. The first is the verbal part of the questions, the second is the pictorial part, and the third is the organisation and the presentation of the information included into the two previous parts of the questions.

The verbal part of the written questions should include words familiar to the students with dyslexia in order to overcome their low memory abilities [15], [9]. In the case of words that symbolise difficult physical quantities the optical representation of the basic elements of these quantities is a proposed solution [16]. As for the structure and the content of the phrases of the questions the proposed criteria are: i) phrases which include as few words as possible [17], ii) phrases written in affirmative form [18], iii) the content of the questions should correlate to the previous knowledge of the students [19].

The pictorial part of the questions should be designed after a cautious selection of the pictures accompanying the questions so that students with dyslexia do not encounter reading problems [19]. The pictures should have the following characteristics: a) The rough drawing of the represented objects is preferred instead of the photos, and the pictures should elucidate the information included in the verbal part of the questions [20]. b) The difference between the dimensions of the represented objects and their dimensions in nature should be the minimum [21] e.g. the representation of a ball as a disc -two dimensions- instead as one point -one dimension-. c) The symbols representing more than one meanings should be clear [22], e.g. Q for the electric charge, Q for the heat.

The organisation and the presentation of the information included in the verbal and the pictorial part of the written questions should have the following characteristics. a) The information of the verbal part should be contained in the pictorial part as well so that both hemispheres of the brain are stimulated and therefore both the L and the P type of students with dyslexia improve their reading ability [7]. b) The information should be represented if possible in alternative form (table of data, diagrams, and so on) [16]. c) The information should be organised in such a way as to emphasise the quantities the students are demanded to estimate and/or find so that the brain keeps them in the long-term memory as high important information [15], [23].

4.2. Application of the criteria to the writing of questions

In this stage, we attempted to apply the above mentioned criteria to the construction of a specific question of Physics. The question was written according to the criteria mentioned above and its content referred to the section “electric field” which was taught in the second class of the lyceum. The construction of the question is described in the following paragraphs.

In the verbal part of the question we attempted to use words familiar to the students. The familiarity of the words was defined according to the relative frequency of each word in the theoretical part of the school-textbook. We constructed a “familiarity indicator” (f.i.) in order to estimate the level of familiarity of the question. The formula which estimated the f.i. of the question was the following:

$$f.i. = \frac{\sum_{i=1}^k N_i(rf)_i}{\sum_{i=1}^k N_i} = \frac{N_1(rf)_1 + N_2(rf)_2 + \dots + N_k(rf)_k}{N_1 + N_2 + \dots + N_k}$$

k = the number of the words used to estimate the f.i. of the question, N_i = frequency of the word i in the question, $(rf)_i$ = relative frequency of the word i of the question in the school textbook.

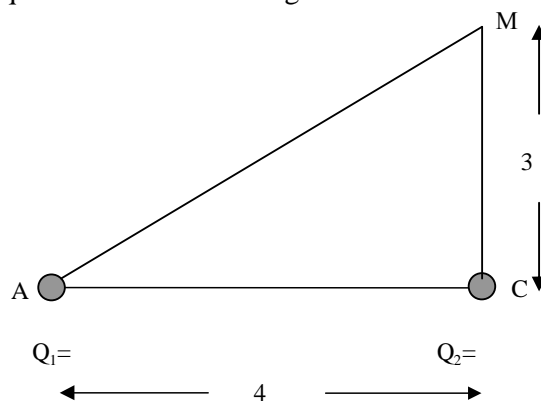
We have to notice that for the estimation of the f.i. we used only the words that correlate to the conceptions of Physics because we considered that the rest of the words would be familiar to the students from the instruction of other school subjects. In order to estimate the level of familiarity of the question we calculated the f.i. for each question of the school textbook that correlated to the “electric field”. The average value of the f.i. of the questions of the textbook was 4,2 and the f.i. of the question we wrote was 6,5 which is rather satisfactory. As for the rest of the proposed criteria for the construction of the verbal part of the question, we attempted to apply them all, e.g. the affirmative type in the phrases and so on. The verbal part of the question is shown in paragraph 4.3.

As for the pictorial part we designed the picture in such a way as to apply the above-mentioned criteria. Therefore, we designed the electric charges and the distances described in the verbal part in order to elucidate this information in the pictorial part. The symbol of the electric charge (Q) is included in the picture in order to avoid confusion with the symbol of the heat (Q). The picture of the question is shown in paragraph 4.3.

As for the organisation and the presentation of the information we noticed that the information which was included in the verbal part was included in the pictorial part of the question as well, therefore there was no need to make any alteration. We only made bold the letters of the words “intensity of the electric field” in order to emphasise them, because they correlate to the physical quantity students are demanded to estimate.

4.3. Form of the question

The form of the question is the following:



“The electric charges $Q_1=+4\mu\text{C}$ and $Q_2=+4\mu\text{C}$ are stable at the points A and C. You have to calculate **the intensity of the electric field** at the point M which is created by the two electric charges. $k_c=9\times 10^9\text{Nm}^2/\text{C}^2$, $\hat{ACM}=90^\circ$, $(AC)=4\text{m}$ and $(CM)=3\text{m}$.”

5. Educational implications

In this paper, we attempted to present an alternative procedure of writing questions of Physics which could be read by students with dyslexia without confronting reading difficulties. We described a series of criteria for the construction of the verbal and the pictorial part of the questions and for the organisation of the information included in these two parts of the questions. The alternative procedure we suggest for the writing of the questions is based mainly on the results of the neuropsychological investigations about the causes of dyslexia. Ending up this paper, we have to notice that the integration of students with special educational needs in mainstream schools is an ambitious and multi-dimensional attempt. We

believe that the teachers play a crucial role in this effort, and their contribution is necessary in order to have successful results. In general, the teachers' positive attitude towards the integration of students with special educational needs in the ordinary education and their active participation in this attempt constitute the necessary requirements for the success of this effort.

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