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Using Ict For Word Mathematical Problem Solving For Students With Dyslexia In Cyprus

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1. Introduction

The last few years, the differentiation of instruction became fashionable in Cyprus after the reformation of the curriculum in primary education. Although, the majority of the teachers supports the philosophy of differentiation, few of them turn it into practice, despite the mixed-ability students' populations in their classrooms. They may not avoid it deliberately but due to the lacks of material-technical infrastructure and knowledge concerning how to adjust their teaching in particular characteristics of their students.
This paper aims to outline a trial for the introduction of an innovating approach for teaching WMPS by bearing in mind the benefits deriving from the use of ICT for the differentiation of the instruction, the restricted technological facilities in mainstream primary-school classrooms in Cyprus, and the particular needs and difficulties of students with dyslexia included in the classroom in WMPS.

2. Theoretical Background

Dyslexia has been acknowledged as a consequence of a problem in phonological processing [1]. According to the phonological deficit theory, students with dyslexia have difficulty in representing, storing and/or producing speech sounds [2] [3] [4].
On the other hand, the value and use of mathematics in school life and life after school is undoubtedly very important. Students with dyslexia usually experience chain failures in school, so as a result their courage and self-confidence are substantially reduced [5]. The difficulties they face in reading and writing, inevitably cause additional difficulties in mathematics. Difficulties in mathematics are even more serious when the problems in short-term and long-term memory, orientation, and automatisation become more severe.
According to the triangle model of reading (Fig. 1), when the phonological pathway between orthography and phonology is weak, then the semantics and meaning are difficult to be reached. Therefore, the difficulty in decoding the letters into sounds, impede the pathway to semantics [6]. For instance, a student with dyslexia who experiences difficulties in reading the text of a mathematical problem will express difficulties in understanding the meaning. It is obvious that he/she will not be able to reach the solution especially when the language and syntax of such mathematical problem is intricate and abstracted.

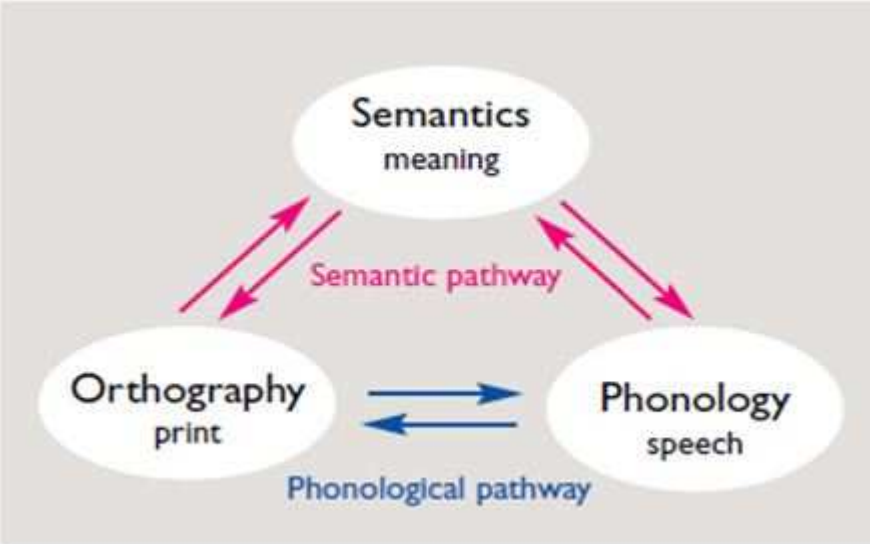

Fig. 1. Triangle Model of Reading [6]

Word mathematical problems contain some information which essentially determines how someone will act to solve it and give an answer. If the problem is not worded to be understandable, then the degree of difficulty increases. For many students, the reading of instructions and details of the text is the most serious difficulty. For the student with dyslexia, in particular, the deciphering of words demands so much energy that the chances of any understanding of the actual text are greatly reduced, and understanding may be defective [7].

Students with dyslexia may face similar difficulties in reading a word mathematical problem to those that they address in reading any text. Apart from difficulties in reading, additional difficulties arise in comprehension and understanding. If a student with dyslexia is unable to read or understand the problem, then it is obvious that he/she will not be able to solve it [8].
In addition, many of the advantages of ICT facilitate pupils with SEN or without SEN. These advantages also apply equally for pupils with dyslexia [9]. An advantage for students with dyslexia is the fact that computers enable multi-sensory elements to be incorporated into the natural education process. Learning becomes easily accessible considering that computers are an exciting way of teaching compared to traditional teaching approaches. ICT constitutes the ultimate tool for better access to the curriculum for every learner [10].
Given the difficulties faced by students with dyslexia in WMPS, a question arises whether the teacher can help the students with dyslexia to understand and solve a mathematical problem by selecting and applying solving strategies and following a five-step problem-solving model suggested by Kulak and Rudnick [11] with the facilities that ICT provides. The five stages are: understanding the problem; investigation of the problem; choice of strategy; problem solving and checking the solution. However, the ICT facilities in Cypriot primary schools are restricted, thus the teacher has limited options to differentiate the instruction under these conditions and that is what this study tries to figure out.

3. Methodology

3.1 Purpose of the Study

This study aims to explore the impact of the use of the available software for the design of learning environments for differentiation of instruction in two different settings on the performance, classroom involvement, and peers interaction of students with dyslexia with difficulties in solving word problems in mathematics. Two different settings will be (1) students of the classroom in pairs using computers in school's lab and (2) student with dyslexia with a parent using the computer at home for homework.

3.2 Participants

The main participants are 22 students attending the 5th grade of a primary school in Limassol, Cyprus. One of the students has been diagnosed as having dyslexia and is included in the mainstream classroom. Additional participants are the teacher of the classroom and the parents of the student with dyslexia.

3.3 Tools for data collection

The tools that have been used for data collection are interviews, observations, screen recordings and pre-tests and post-tests.

3.4 Research Design

The research design was based on case study approach and the procedure has been held in three stages. At the first stage, data concerning the attributes, weaknesses, attitudes of students towards WMPS had been collected. This leaded to the identification of the particular characteristics of the students–characteristics of student with dyslexia included, elements that helped in the design of the learning environment on the computer with the cooperation with the teacher of the classroom. The learning environment has been designed by taking into account the restricted ICT facilities in the Cypriot mainstream classroom and school. It is a dyslexia-friendly, game-like design based on Mayer's multimedia principle which refers to individual preferences in terms of the use of animation, auditory narration and text [12].
At the second stage, the implementation of the differentiated instruction with the use of the computer took place in school's computers lab. Students worked in pairs or groups of three. Instead of solving word mathematical problems with the use of paper and pencil, students were using the designed web-based learning environment which was guiding them to follow the stages for WMPS from the stage of understanding to the stage of choosing the appropriate strategy and then reaching the solution. The learning environment on the computer was providing continues and immediate feedback to students, while the teacher provided additional feedback to all pairs or groups. Students were sitting in pairs or groups not only because the available computers in school's lab were few but also because of the benefits deriving from the collaborating learning [13] [14].
The programme implemented for a period of four weeks in which eight forty-minutes sessions have been held. Apart from the implementation of the programme in the classroom, there was an additional supplementary part which was home-based. For the particular part of the project, only the student who diagnosed as having dyslexia had been selected in order to investigate the potential of new technologies in WMPS for homework especially for the particular student. Four thirty-minutes sessions for the period of four weeks (one session per week) at home with the use of computer and parent's presence were held.
At the third stage, data has been collected for the evaluation of the programme and the record of any potential changes in terms of attributes, attitudes towards WMPS, participation during the instruction and so on.

3.5 Data Analysis

By the end of the third stage of the project, information have been collected on 22 students, in the form of audio recordings, video recordings, observation notes, diary recordings, peers interviews, student's with dyslexia interview, computers' screen recordings, teacher interview, special teacher of the school interview, students' work and essays, pre-tests and post-tests, school documents and student's with dyslexia parents interview. The analysis of interviews transcriptions was based on the idea of content analysis which involves the methodical ascertainment of coded categories based on the frequency of data occurrences in transcriptions [15, 16].

After the analysis, data taken has been compared in order to indicate any potential changes before, during and after the differentiation of the instruction.

4. Discussion – Conclusion

At this stage, data analysis is under processing; therefore the conclusions that can be exported will not be safe. Thus, general conclusions that emerged from early data analysis will be discussed.

Both the student with dyslexia and his classmates want to use the computer during the lessons. It has been observed that the single computer in the classroom is used extensively by the teacher but the students had no opportunity to work individually or in groups on the computer. Students sit in groups of 5-6 pupils which promotes collaborating learning. The teacher encourages students to collaborate, but the student with dyslexia does not contribute a lot in the group. The observations showed low rates of participation in the classroom and specific weaknesses in solving word mathematical problems, a fact that is confirmed by the pre-test results for word problem solving in mathematics and the interviews.

During the differentiation of instruction with the use of the computer, all students showed great interest and enthusiasm. The participation rate was significantly increased. The collaboration in pairs proved to be very helpful as the students showed significant improvement. The direct provision of feedback from the computer proved to be helpful and entertaining. No any change has been observed in terms of acceptance of the student with dyslexia from his peers, although it was observed from the very first time that there were no any problems in terms of acceptance on behalf of peers. Also, positive results have been recorded during the implementation of the programme at home. The student with dyslexia could work more individually and less support from his mother was needed.

However, after the implementation of the programme, no any significant improvements in terms of participation during the instruction without the use of the computer have been observed. The student was participating in the same extent as before. The fact indicates the weaknesses of the programme in achieving permanent and long-lasting changes and improvements when it is applied in short-lasting period. Also, it indicates the difference between a programme for the differentiation of the instruction and an interventional approach to dyslexia.

The results of this research effort are promising. The combination of using ICT during the instruction and the collaborative learning between the student with dyslexia and classmates without dyslexia showed a possibility of using the computer in WMPS in Cypriot primary schools but the same time it showed significant difficulties in implementing the programme in environments with limited ICT facilities. It also showed promising results from the use of the computer for solving mathematical problems at home for students with dyslexia.

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