

# Accommodation for Dyscalculic Children in an E-Learning Environment

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## ABSTRACT

Dyscalculia is a specific learning disability involving innate difficulty in learning or comprehending simple arithmetic. The purpose of this paper is to identify various problems faced by dyscalculic children and provide various accommodations to cater the needs of these children in an e-learning environment.

## General Terms

E-Learning, Human Computer Interaction, Disabilities

## Keywords

E-learning environment, Learning Disability, Dyscalculia, assessment methods, special needs

## 1. INTRODUCTION

The development of e-learning over the last two decades has meant dyscalculia students can now access to any learning resources at anytime from anywhere in a way that they could not do before [1]. These students are now benefiting from the advances in learning technologies that provide comprehensive interactive access to text based, audio, video material. But most of the e-learning systems are not inclusive in nature; they do not cater the needs of all type of disabilities [2]. Dyscalculic students have varying requirements when accessing e-learning environment. Basically the word "Dyscalculia" comes from Greek and Latin word which means: "counting badly". The prefix "dys" comes from Greek and means "badly". "Calculia" comes from the Latin "calculare," which means "to count"[3]. Dyscalculia is about difficulties related with numbers and arithmetic, and not about other branches of mathematics, such as geometry.

This paper mainly focuses on the problems faced by dyscalculic students and the need for various accommodations in the existing e-learning system. And it is organized as follows: types and characteristics of dyscalculic students in Section 2. In Section 3, we describe difficulties of inaccessible e-learning systems. In Section 4, we provide accommodation approaches for them; Section 5 concludes the paper.

## 2. TYPES AND CHARACTERISTICS OF DYS CALCULIC STUDENTS

Dyscalculia is comprised of all the difficulties related to the acquisition of the concept of number, of arithmetic calculation and mathematical reasoning. Some people can be good mathematicians, but still be hopeless with simple calculations. Although math learning difficulties occur in children with low IQ, dyscalculia can also be found in people with normal to superior intelligence [4]. Those who suffer from a mathematics disorder usually suffer from other learning disorders as well. Dyscalculia often has a form of visual processing difficulty

associated with it. An individual suffering from a visual processing difficulty is unable to see the difference between two similar letters, shapes or objects. A person with dyscalculia may need special education services to treat this neurological disorder [5]

## 2.1 Types of Dyscalculia

There are two subtypes of mathematics disorders [6] :

### 2.1.1 Mathematical Computation Disorder

Mathematical Computation Disorders affect an individual's ability to solve math calculations. A person with this type of dyscalculia may have difficulty completing simple addition, subtraction, multiplication, and division problems

### 2.1.2 Mathematical Reasoning Disorder

Mathematical Reasoning Disorder affects an individual's ability to utilize mathematical reasoning to solve problems. People with this type of dyscalculia or mathematics disorder have difficulty with abstract concepts of time and direction.

## 2.2 Characteristics of Dyscalculic students

The following are the characteristics of dyscalculic children seen in primary school [7]:-

- Five to seven year-old dyscalculic child show less understanding of basic counting principles than their peers.
- Difficulties in memorizing arithmetic facts
- Dyscalculic children particularly face difficulty with subtraction.
- Difficulty understanding place value.
- Trouble learning and understanding reasoning methods and multi-step calculation procedures.
- Shows difficulty understanding concepts of positive and negative value, carrying and borrowing.
- Has difficulty in understanding and doing word problems.
- Has difficulty understanding concepts related to time such as days, weeks, months, seasons, quarters, etc.
- Difficulty in imagining a mental line number.
- Exhibits difficulty organizing problems on the page, keeping numbers lined up, following through on long division problems.
- Difficulty measuring and estimating things.

## 3. THE DIFFICULTIES OF INACCESSIBLE E-LEARNING SYSTEM

E-Learning system makes use of information and communication technology (ICT) to provide innovative ways to learn. Appropriate designed e-learning system can provide significant opportunities to create and acquire knowledge for themselves [8]. E-learning may appeal to students if they have commitments which make it harder for them to attend

regular course or if they want to learn when and where they want, at their own pace. Following skills are required by the learner for e-learning:

- Observation
- Attention
- Manipulation
- Problem Solving

But a dyscalculic students not only lack in arithmetic skills but they also lack in some of the above skills. So it becomes very difficult for them to fully utilize the existing e-learning system.

## 4. ACCOMODATION FOR DYSCALCULIC STUDENTS

Accommodations are alterations in the way tasks are presented that allow dyscalculic students to complete the same assignments as other students. The students with dyscalculia need accommodations in order to make things possible for them without being impeded by their disability.

### 4.1 Types of Accommodation

The categories of accommodations are as follows:

#### 4.1.1 Pedagogical Accommodation

The pedagogy plays a very critical role from dyscalculia and e-learning point of view. Following strategies are taken into consideration to teach dycalculic student with respect to e-learning environment:

- Teach different ways to learn math facts instead of memorizing basic addition facts.
- Teach any new concepts by starting with concrete and slowly moving to more abstract examples.
- Provide specific instruction to help them understand the language and symbols used in maths.
- Appropriate aids such as number squares and calculators should be available and students should be taught how to use them.

The pedagogical accommodation may keep on varying depending upon the IEP [Individual Education Plan] of the dyscalculic students.

#### 4.1.2 Presentation Accommodation

Hard coded presentation elements such as fonts may make access impossible for some type of dyscalculic students. In order to make the application versatile, following presentation parameters are considered:

- Font, font style, font color and font size.
- Audio
- Cursor size, style and blink rate
- Size of text and images, including video
- Screen Layout, colors and background.

The above parameter must be customized depending upon the requirement of dyscalculic students.

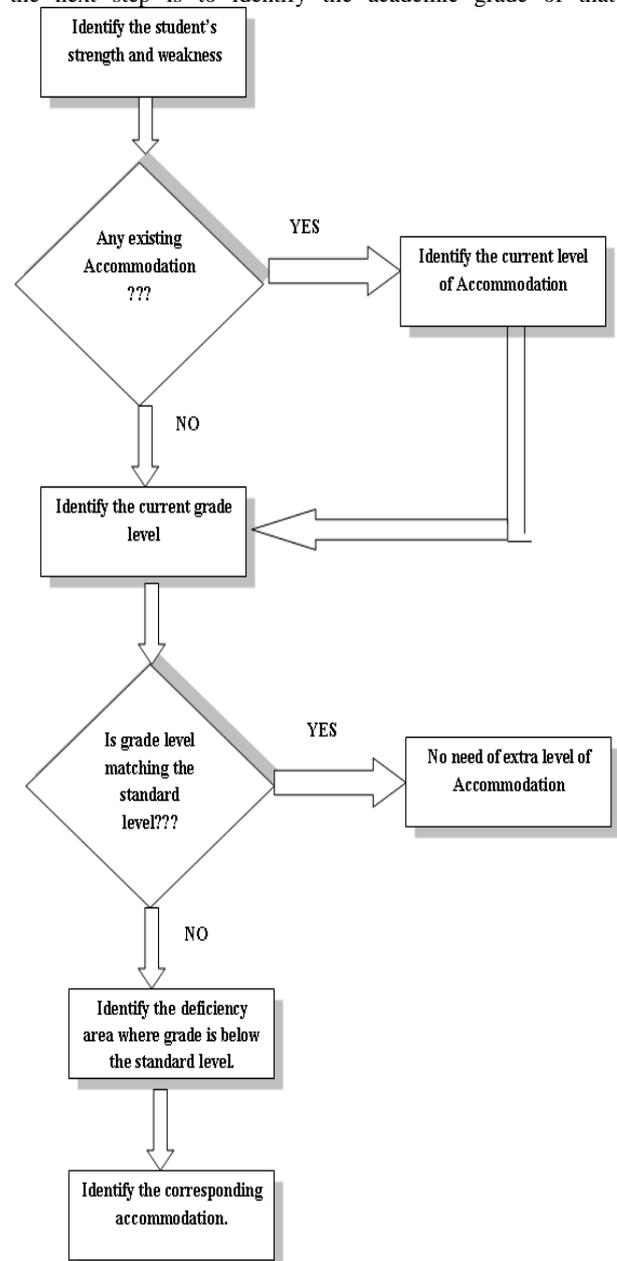
#### 4.1.3 Test Accommodation

Dyscalculic students take long time to complete their math paper. So various parameters with respect to test accommodation are as follows:

- Extended exam time, typically time and one half to double time.
- Use calculator for exams
- Conduct oral exams rather than written exams.

## 4.2 Selection of the Accommodation

As shown in the fig 1, there is a sequential flow through which the appropriate accommodations are selected. Every student with dyscalculia has its own Individualized Education Plan (IEP). This plan is prepared based on students list of strength and weakness. It also contains information related to the existing level of accommodation. Once the current accommodation level of the dyscalculic student is identified, the next step is to identify the academic grade of that



**Fig 1. Steps for selection of appropriate accommodation for dyscalculic student**

dyscalculic student. Now based on that grade, a check is made to find out if the grade matches the standard level or not. If it matches then no extra accommodation is required for them. If there is no match then the deficiency area is identified on the basis of low grade and only on those areas, appropriate accommodations are provided as shown in the table 1. It highlights on each accommodation type with an example.

**Table 1. Accommodation based on deficiency area**

Deficiency Areas	Type of Accommodation	Examples
Difficulties in memorizing arithmetic facts	Pedagogy	Teach different ways to learn math facts instead of memorizing basic addition facts
Trouble in solving multi-step calculation.	Test	Usage of math calculator
Difficulty in understanding word problems	Presentation	Use large font with proper words spacing

## 5. CONCLUSION

Children with dyscalculia are spotted by their poor performance in school math, losing track in math lessons, inability to deal with numbers in everyday life situations, such as shopping, telling the time and remembering phone numbers. These children can have average or even much better than average performance in other subjects. By providing accommodations in their deficiency area, the performance of these students can increase. Our paper focused on three most common accommodation required by dyscalculic student i.e. pedagogy skills, presentation techniques and test provisions. With help of these accommodations, dyscalculic student can gain confidence in their mathematical capabilities.

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