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Interactive Whiteboard Use for Developing Phonological Awareness in SEN Students

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Abstract

This paper considers the impact of using interactive whiteboards to promote phonological awareness among SEN students through whole-class online activities. Data collected suggests the tactile features of IWB, as well as the added game elements increase the students' learning motivation and the task completion rate.

The results indicate this specific type of technology has the potential to facilitate a better understanding of word structure in students with developmental / intellectual disabilities and it appears to motivate and engage them in learning more than traditional literacy activities.

Keywords: phonological awareness, phonological awareness training, intellectual disability, special educational needs, technology, interactive whiteboards

Introduction

Reading comprehension skills are essential not only for school performance, but also, and more importantly, for their role in adaptation and enabling an independent life, as written communication is still one of the most common ways of conveying information.

Teachers employ various strategies to enhance literacy skills in typical students, but these strategies don't always work in a special education learning environment.

Intellectual disability affects children's development at all levels and it is characterized by significant limitations of all cognitive functions. For instance, at perceptual level, children with intellectual disabilities have difficulties processing sensory information, which translates into perceiving objects globally, and not as systems comprised of individual interrelated elements. Such a challenge can hinder understanding of speech and the structure of language. A direct result of this challenge is the fact that children with mental disabilities face difficulties in developing literacy skills because the traditional method of teaching these skills, the analytic-synthetic method, relies heavily on cognitive skills that are affected by mental deficiency. This greatly impacts teaching methods, which now, more than ever, need to be reassessed in order to render the contents more accessible and to optimize the learning process for SEN students.

Several studies have highlighted in the recent years the role of phonological processing skills in the development of reading skills. In a restricted sense, phonological awareness signifies a specialized ability to recognize and distinguish the smallest units (sounds) of language, an essential ability for developing the more complex ability of reading comprehension, which is the final goal. If phonological training is recommended to facilitate the development of reading and writing skills in neurotypical children, it is all the more necessary, vital even, when attempting the same in children with intellectual disabilities.

Moreover, previous research (Ehri et al., 2001) has demonstrated that the level of phonological awareness is the best predictor of reading success, which is why training and developing these skills should be a priority for all educational factors. Unfortunately, they are not always a priority in mainstream classes, and even less so in special needs classes. Particularly

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in special schools this is difficult to achieve and for more than one reason: firstly, because specific learning difficulties present in the special school's student population make learning objectives difficult to achieve and secondly, but also important, the lack of tailored teaching materials needed to implement such teaching programs.

The need to reexamine the work practices, imposed by the new epidemiological context, offered unexpected opportunities to adapt typical teaching materials for use on the interactive whiteboard. The use of interactive whiteboards has proven effective in more than one way: on one hand, the tactile features that allow object manipulation on screen facilitate a deeper understanding of the structure of language, and on the other hand, merely the simple use of electronic devices as an educational tool increases the learning motivation of students, as they are usually associated with games / rewards, and, as such, much more attractive than traditional materials.

Phonological Awareness

Phonological awareness is the complex, multileveled ability to understand the structure of language that many studies have shown to be necessary to master not only for the alphabetical code present in all languages, but also for different writing systems, such as those used in China or Japan (Seki et al., 2008).

Essentially, phonological awareness mainly consists in the ability to identify, discriminate and manipulate sounds at word level. This ability to distinguish between the smallest units of language that make up words is the most important prerequisite skill needed to acquire reading and writing skills, which is why they are considered the safest predictor of success in their acquisition. In contrast, the lack of phonological awareness skills seems to be a major obstacle to acquiring these skills: children who are not able to segment words and syllables into phonemes do not develop the decoding skills necessary to learn to read and write.

A more comprehensive definition is proposed by Morais (1991, in David & Roșan, 2019):

"Phonological awareness is the cognitive ability to represent and manipulate phonological units, a skill that enables the analysis of sound flow and its subsequent coding in written language, both in general - in order to understand the alphabet, and in particular - in order to deliver a series of phonemes in sequence."

Phonological processing takes place at unconscious level in oral communication, because its role is to extract meaning from the message and not to observe the sequence of language units in speech. But if this process is automated in oral language, the same cannot be said about reading and writing, which requires language analysis skills that do not develop naturally and are not easy to acquire.

Research (Anthony & Francis, 2005) has identified three types of phonological processing abilities:

• phonological memory is the temporary coding of information in a system of sound representations (for a limited period of time)

• rapid automatized naming is the efficiency with which phonological codes are extracted from memory

• phonological awareness is the ability to distinguish the sound structures of oral language

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Of these, phonological awareness is most often related to written language acquisition. Phonological awareness, in turn, includes a set of skills of its own, among them:

Word and Rhyme Awareness

• word awareness is the ability to discriminate between the distinct words of a sentence; typically, a child with this ability can say how many words there are in a given sentence;

• rhyme recognition is the ability to recognize similar sound structures in different words, such as the sequence of sounds “oat” in the words “coat” and “goat”;

• rhyme production is the ability to identify words that rhyme with a given word.

Syllable Awareness

• syllable identification is the ability to recognize syllables as language structures consisting of several phonemes that are part of words;

• elimination of syllables is the ability to indicate the remaining sound structure left in a word after the elimination of a syllable;

• syllable substitution is the ability to transform words by replacing one syllable with another.

Phoneme Awareness

• phoneme isolation is the ability to recognize individual sounds in words;

• initial, final, medial phoneme isolation & identification is the ability to identify beginning, medial, and ending sounds in words

• phoneme blending is the ability to recognize a word based on its parts (phonemes);

• phoneme segmentation is the ability to identify individual sounds in sequence in a given word;

• phoneme substitution is the ability to transform words by replacing one sound with another.

Among various methods of teaching literacy proposed over the years, one has consolidated its leading position in the last decades - the analytic-synthetic method, most specialists praising its efficiency. Also, it is widely accepted that the technical skills of blending and segmenting language units, skills acquired through the phonetic method, are essential for understanding reading and writing language.

Our language is a phonetic language, and naturally, over time, this method has, too, become the norm in Romanian education. But this method is not the only one that has proven effective in developing phonological skills.

David & Roșan (2019) describe several methods of developing phonological awareness, some of which are illustrated in a detailed phonological training program.

The Analytic-Synthetic Method

As the name suggests, this method comprises of two approaches, namely phonemic analysis and synthesis, which, used gradually, but together, facilitates the acquisition of reading skills. The analytic phase proposes starting from syntactic units, the sentences, that are gradually segmented into smaller and smaller units until the smallest one of them is identified - the phoneme. The synthetic phase reverses the process by reconstructing the sentence is from the

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smallest unit to the global message. One of the most frequently cited disadvantages of this method is that it entails learning the code of the written language (i.e., the letters of the alphabet) before acquiring reading comprehension skills, so the student is deprived of understanding and context. Until they have mastered all the letters of the alphabet, students cannot understand the meaning of a written text.

An even more important limitation, especially in relation to intellectual disability, is given by the fact that this method involves the use of cognitive skills - analysis and synthesis – that are challenging for SEN students and as such they will have difficulties acquiring reading skills by way of this particular method. Despite mentioned limitations and challenges in teaching students with intellectual disability, experts still recommend it as the most suitable method for developing phonological skills and subsequent reading skills. However, they emphasize the need to adapt it to accommodate the specific cognitive profile of students with special needs.

The Suzanne Borel-Maisonny Method

The Suzanne Borel-Maisonny method is a phonetic and gestural method created last century by Suzanne Borel-Maisonny. It is currently employed as a speech therapy technique, as well as a method of acquiring phonological skills, followed by reading and writing skills respectively.

"We are actually talking about two different uses of the same method, whether it is children who need speech therapy rehabilitation, or children who learn to read. Suzanne Borel-Maisonny laid the foundations of speech therapy, and Clotilde Silvestre de Sacy adapted it as a method for acquiring reading and writing skills." (Sacy, 2020)

The method consists in associating a unique gesture with each phoneme of the language, regardless of its graphical representation. The interest sparked by this method in the scientific community was triggered by the visible improvement of letter recognition performance, a progress facilitated by the activation of motor memory during this process. The author initially used this method during speech therapy sessions with children affected by dyslexia, dysorthography or hearing loss.

Clotilde Silvestre de Sacy, a teacher who became a close collaborator of Suzanne Borel-Maisonny, proposed to expand the use of this method to include it in reading comprehension activities. The method has also proved extremely useful in preventing reading and writing disorders. Since 1960, this method has been used in

Elkonin Method (Sound Boxes)

Initiated by Elkonin (hence the name) and developed by Blachman, this method uses a simple diagram to illustrate the sound structure of words in the form of boxes grouped under the image of the word, which gives students visual support in decoding the phonemic sequence. Diagrams can be used in various ways:

• to develop vocabulary skills by naming and describing images, as well as forming sentences based on them;

• to distinguish between phonemes that form words, by marking each one with a token in each box;

• for phonetic analysis and word reading / writing by placing the chips with the corresponding letters in each box.

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The Elkonin method is a versatile method which provides ample support to students in developing their phonological skills, whether they are in the first stages of acquiring reading skills or later on, to consolidate them.

Castiglioni-Spalton & Ehri Method

The Castiglioni-Spalton & Ehri method was developed from the same principle of using representational clues that help students distinguish sounds and discriminate between the phonemes that make up the word.

The method has its origins in the same theory of motor speech perception as the Borel-Maisonny method, the difference being that Borel-Maisonny method uses gestures associated with phonemes to help distinguish them from one another, whereas the Castiglioni-Spalton & Ehri method uses representations of articulatory movements for the same purpose.

In a comparative study (Castiglioni-Spalten & Ehri, 2003) the authors experimented with two means of facilitating the development of phonemic analysis skills:

• a group of children used images of articulatory movements that they arranged in sequence to recreate the sound structure of the word

• a second group of children had the same task (to recreate the phonemic structure of the target word), but by using cubes that were also placed in sequence of articulation to represent the sounds

• a (control) group of children did not benefit from any phonological instruction

The study results revealed that both experimental groups improved their phonological skills (compared to the control group), but only the first group of children (who used images of articulatory movement) was able to transfer these skills to reading.

A number of studies (Sermier Dessemontet et al., 2017) have demonstrated in the recent years how phonological skills and their development are affected by intellectual disability.

Apart from demonstrating significantly lower levels of phonological awareness, children affected by intellectual disabilities also present atypical characteristics in the development of these skills.

Such a characteristic is developing phonemic awareness before developing rhyme awareness, an anomaly explained by some authors (Conners et al., 2006) by poor verbal memory that is also present in the cognitive profile of these students.

Another characteristic is the apparent ease with which they memorize the letters of the alphabet compared to the difficulty of manipulating them to form words and develop reading comprehension skills.

As a general rule, there is a significant difference between the level of emerging phonological awareness skills, such as global reading, letter recognition or phoneme-grapheme correspondence, which students with intellectual disabilities master more quickly, sometimes even at the typical age of development of these skills, while more complex skills develop at a much slower rate and remain deficient for a long time. The difficulties they face in discriminating between the sound structures that make up oral language delays the development of reading skills, which, over time, prevents the development of automatic word recognition and reading skill, with all the consequences that stem from this and affect the overall development of the child.

Another important aspect that should be considered when developing phonological skills in students with intellectual disabilities concerns the verbal working memory and its role in the

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acquisition of reading and writing skills, a causal relationship that has been amply demonstrated in numerous studies.

Interestingly, by definition, working memory has an executive function based on two subsystems: a phonological one, responsible for storing verbal information and a visual-spatial one, responsible for storing visual and spatial information. Students with intellectual disabilities are affected in both areas: poor phonological memory hinders the phonological processing of the sound structure of words, while visual and spatial discrimination difficulties lead to confusion between similar letters, mirror-reversed letters and reading, difficulties with spatial organization and page orientation.

However, despite all these challenges, the literature is in full consensus on phonological instruction. All studies observe that quality intervention instruction focused on all these aspects invariably results in a substantial improvement of phonological awareness skills and subsequent development and ultimately acquisition of reading skills.

Although there are not enough studies that offer a clearly outlined profile of all the characteristics of phonological awareness that are present in intellectual disability, we can at least extract from all the existing ones a very encouraging and optimistic conclusion, and that is the potential to overcome the observed deficits.

Some authors (Sermier Dessemontet et al., 2017) mention the possibility to extend the usual period of phonological instruction all the way throughout primary school in order to support the transition to reading and writing activities. They especially recommended personalizing instruction to accommodate different types of disabilities, cognitive traits and progress rates. These specialists also draw attention to the fact that some educational factors or teaching methods may delay the transition from one level of phonological awareness to another, even though students are prepared to move on to more complex tasks - the classic example being the one mentioned earlier, of students who fail to master rhyme awareness, but demonstrate phonemic awareness skills.

Research Methodology

This particular context was the basis of this study, that aimed to determine the effect of using digital resources designed for interactive whiteboard to improve phonological skills in students with intellectual disabilities.

Specifically, the research sought to analyze the extent to which the systematic use of the interactive whiteboard resources during Language and Communication classes can promote phonological awareness in students with intellectual disabilities. Specific objectives proposed for this study included:

- to determine the level of phonological awareness skills for students included in the research group;

- to design a structured phonological awareness training program using IWB resources;

- to study the relationship between the use of IWB resources to promote phonological awareness and the phonological awareness skills levels observed in students included in the research group.

We developed our research from the presumption that the use of interactive whiteboard resources and tasks as a mean to enhance phonological awareness in children with intellectual disabilities will determine an increase in their level of phonological awareness. Given the heterogeneous nature of the study group, we also assumed that the students' level of general

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intelligence, as expressed in their IQ score, is in a statistically significant relationship (of direct proportionality) with the level of their phonological skills. The specific phonological training activities included in the training program were integrated in the Language and Communication classes that took place during online school throughout the first semester of this school year.

The study group is uniform in terms of age and gender (3 girls and 3 boys aged 12-13), but displays the usual lack of homogeneity observed in all special education classes when it comes to their level of intelligence, a hindrance sometimes intensified by the difficulties of assessing cognitive abilities in SEN students, especially those on the autism spectrum (4 students with severe intellectual disabilities and 2 students with moderate intellectual disabilities).

Assessment of students' phonological skills was achieved using a test structured on the basis of the three levels of complexity discussed at length in the previous chapter - rhyme awareness, syllable awareness and phonemic awareness. We used a Romanian adaptation of the P.A.S.T. - Phonological Awareness Skills Test (Simon, 2019), a widely used instrument by schools all over the US, despite not being standardized. The test assesses the three dimensions of phonological processing skills that also serve as dependent variables.

The performance level descriptors for Rhyme Awareness are:

- Recognizing rhyme in verse;
- Recognizing rhyme in isolated words;
- Producing a word that rhymes with a target word.

The performance level descriptors for Syllable Awareness are:

- Segmenting given words into syllables;
- Blending syllables to form a given word;
- Locating target syllables in given words.

The performance level descriptors for Phoneme Awareness are:

- Blending phonemes into words;
- Segmenting words into individual phonemes;
- Locating a target sound in given words.

The initial testing results for all three variables reveal an average score of ~9 points obtained for all three variables that are the equivalent of less than 30% of the maximum score given to each of these variables. The mean values obtained are presented in the table below:

		Rhyme Awareness (initial test)	Syllable Awareness (initial test)	Phoneme Awareness (initial test)
Group	Mean	9.33	9.67	8.67
	N	6	6	6
	Std. Deviation	7.581	7.257	8.779

The results revealed similar values for all three variables, only slightly lower scores were obtained for Phoneme Awareness, possibly due to the fact that this variable measures an ability of a higher complexity than the other two, a skill that develops later and it is much more affected by intellectual disability. Various studies suggest there is a complex of factors that hinders the acquisition of these skills, such as poor cognitive skills and / or other developmental disorders that affect motivation and behavior (autism spectrum disorders, attention deficit hyperactivity disorder, etc.). The results also revealed high values for the standard deviation, which we

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propose are due to the unequal distribution in terms of general intelligence among the members of the study group, a characteristic that can lead to significantly different results within the experimental group. Specifically, the results show significant differences between the scores obtained by students with severe mental deficiency and those with moderate mental deficiency - at least 7 points for Rhyme Awareness between the two groups and at least 10 and 11 points, respectively, for the other two variables, which indicate a difference of about 30% in their level of performance. These results support one of the research hypotheses previously mentioned, that phonological skills are highly dependent on the general cognitive skills. We also followed this hypothesis in the second part of the research, observing how the IQ score affects not only the test results, but also the progress of acquisitions during the implementation of the program.

This data analysis guided the effort to design a phonological training program structured on several levels of phonological skills that correspond to both the assessment test items and the research variables:

• Rhyme Awareness level - recognizing rhyme in verses with / without meaning, identifying rhyme in verses with / without meaning, identifying rhyme in isolated words, producing rhymes by recalling from memory words that rhyme in familiar texts or by producing words that rhyme with a target word;

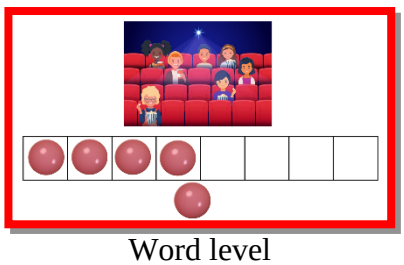
• Syllable Awareness level - segmenting words into syllables and counting them, blending syllables into words, grouping words by a given syllable, locating a target syllable in a given word, deleting a syllable from a given word;

• Phoneme Awareness level - identifying the initial / final sound, locating a sound in a given word, phonemic blending and segmentation.

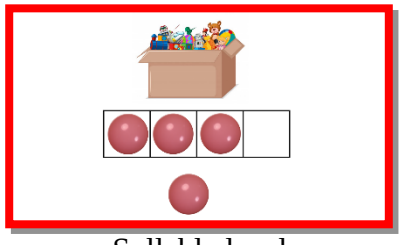
The initial, central assumption proposed by this study was that these objectives can be achieved faster and more efficiently by using interactive whiteboard digital resources in the phonological training program, assumption which guided both the contents and the presentation of teaching materials. For this purpose, interactive activities were created for use on Jamboard, an application that is accessible to all students through the Google Education Suite, the platform used for online activities.

In the instructional design of the program, we aimed to adapt the main methods of developing phonological awareness identified in the literature to the specific format of online activities.

For instance, the adaptation of the Elkonin (Sound Boxes) method to the digital format was achieved for all levels of phonological awareness (word, rhyme, syllable, phoneme), both by using tokens to mark language units and by using moving letters that can be manipulated on the screen so that, following the identification of individual phonemes that make up the word, the students can form words with different levels of complexity (CVC, CVCV, etc.). Here are some examples of phonological training activities based on the Elkonin method and created in the Jamboard application.



Word level



Syllable level

Phoneme level

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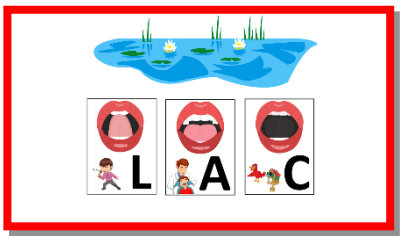
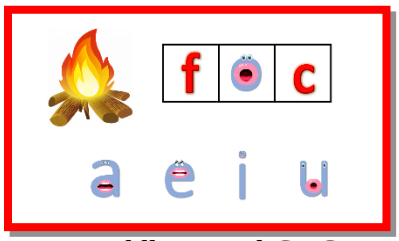
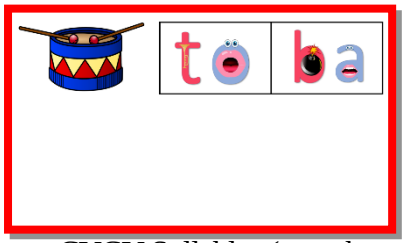
The concept of facilitating the acquisition of phonological skills by associating each phoneme of the language with a visual, auditory or gestural clue, a method proposed by several specialists, was adapted to the virtual environment by using speech sound visual cues or by using special alphabet letters, whose shapes help students recall either the articulatory movement of the phoneme or an onomatopoeia evocative of that phoneme.



CVC Words (speech sound visual cue + onomatopoeia)



Middle Vowel CVC (speech sound visual cue)

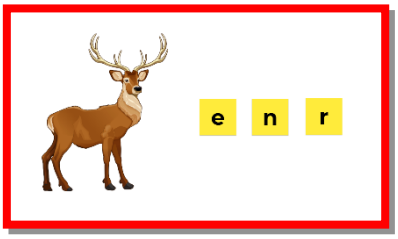


CVCV Syllables (speech sound visual cue + onomatopoeia)

The tactile features of the interactive whiteboard have been capitalized on by creating learning activities that include numerous game elements. The possibility to display virtual manipulatives on the whiteboard in the shape of tokens, letters, images, etc., allows teachers to design various tasks that are attractive the students, such as association games, jigsaw puzzles, finding the odd one out, etc., all of which are easily adaptable the new contents.


Rhyme Identification

Target Syllable



CVC Anagrams

Data analysis and interpretation following retesting aimed to establish the extent to which the phonological training program designed to be used with the Jamboard application determined significant changes in the students' test performance for all three variables. As we used repeated measurements at different intervals, we employed the t test for paired samples as a statistical method. The statistical findings are illustrated in the tables below:

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Rhyme Awareness – T_1	9.33	6	7.581	3.095
	Rhyme Awareness – T_2	12.50	6	9.072	3.704

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Pair 2	Syllable Awareness – T_1	9.67	6	7.257	2.963
	Syllable Awareness – T_2	14.67	6	9.832	4.014
Pair 3	Phonemic Awareness – T_1	8.67	6	8.779	3.584
	Phonemic Awareness – T_2	13.00	6	9.839	4.017

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Rhyme Awareness (T_1) & Rhyme Awareness (T_2)	6	.954	.003
Pair 2	Syllable Awareness (T_1) & Syllable Awareness (T_2)	6	.965	.002
Pair 3	Phonemic Awareness (T_1) & Phonemic Awareness (T_2)	6	.993	.000

Paired Samples Test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Rhyme Awareness (T_1) - Rhyme Awareness (T_2)	-3.167	2.927	1.195	-6.238	-.095	-2.650	5	.045
Pair 2	Syllable Awareness (T_1) - Syllable Awareness (T_2)	-5.000	3.406	1.390	-8.574	-1.426	-3.596	5	.016
Pair 3	Phonemic Awareness (T_1) - Phonemic Awareness (T_2)	-4.333	1.506	.615	-5.913	-2.753	-7.050	5	.001

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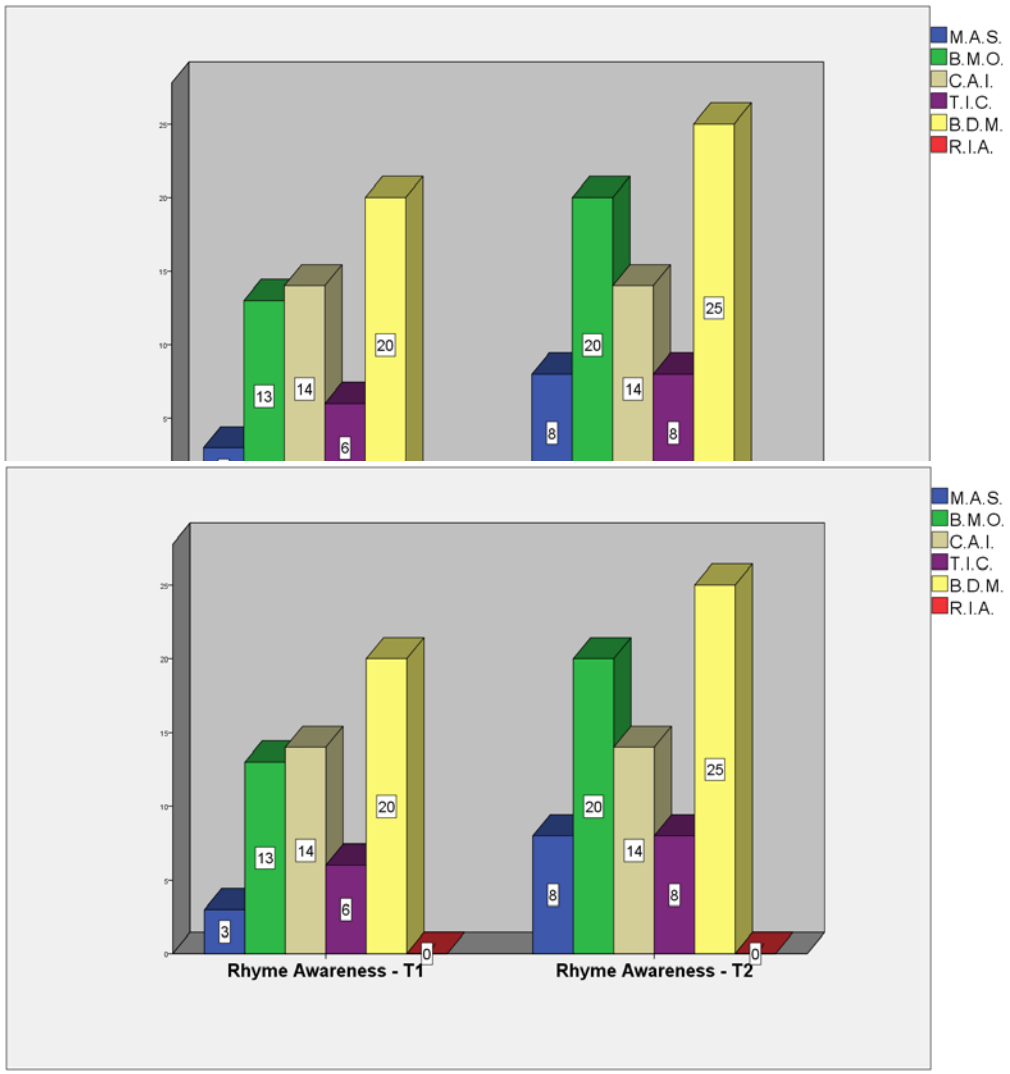
As a correlation coefficient higher than 0.75 indicates a very good correlation, the statistical data shown in the table also suggests a good correlation between the use of IWB and the development of phonological skills in SEN students, namely r = 0.95 for the first variable, r = 0.96 for the second variable and r = 0, 99 for the third variable. Further evidence of the efficiency of the program is the shown p-value of less than 0.05 for all variables.



A graphic illustration of the compared results for all three variables is presented below.

Following a second test, the mean values obtained for the Rhyme Awareness variable are ~13 points, which is indicative of an overall 14% improvement of performance. With one exception, we observe increased performances in all students of the group. We can also note the significant difference between the results obtained by students with moderate mental deficiency and those with severe mental deficiency, at both tests.

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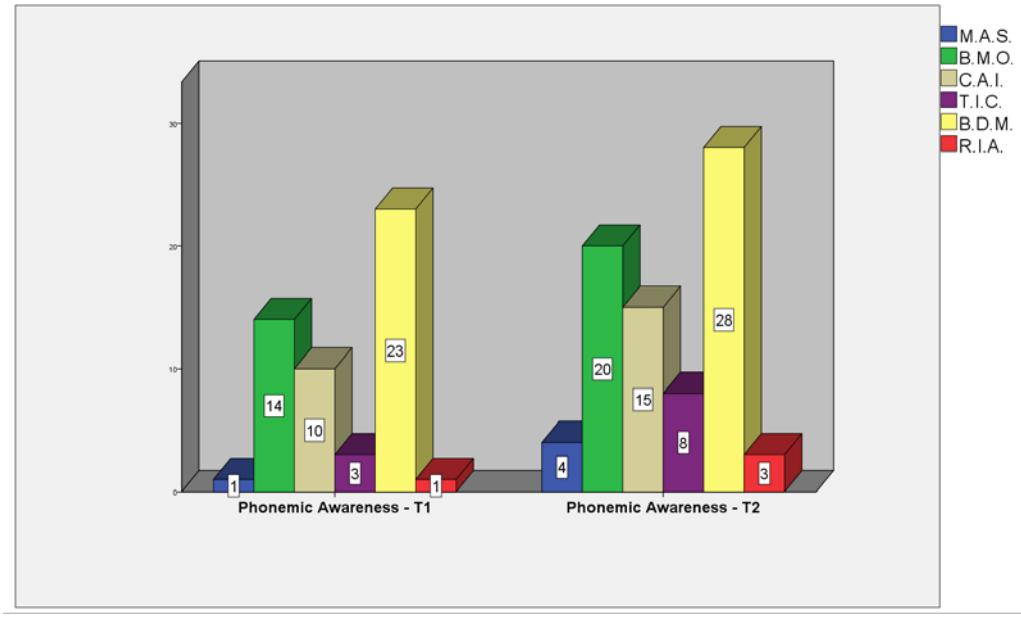
The average scores of ~15 points, obtained for the Syllable Awareness variable suggest an overall performance improvement of 17%. Apart from the previously mentioned exception, the results seem to indicate again increased performances for all students, with significant differences depending on IQ, not only in relation to both test results, but also to the general level of progress between the tests.

The mean values reported for the Phonemic Awareness variable, of 13 points, reveal a similar increase in performance of approximately 17%. Surprisingly, although phonemic awareness is a more complex skill, we can observe some degree of improvement in all students, including those who previously did not perform at seemingly less difficult tasks. This is likely due to the fact that students with severe mental disabilities sometimes make correct choices when presented with phonemic awareness tasks through global word recognition, and not through phonemic analysis, thus getting positive results, but lacking a thorough understanding of the sound structure of words.

Summarizing the results obtained for all variables we ascertain an overall improvement in students' performance on the phonological skills assessment test by approx. 16% following the training program, results which confirm the research hypothesis that "incorporating IWB digital resources in the phonological awareness training of students with intellectual disabilities will determine an increase in their level of phonological skills".

Conclusions and limitations

Our research limitations are related to the sample size and its lack of homogeneity, as well as to the current situation in which a teacher's relationship with their students is mediated by parents, which is bound to affect the accuracy of the evaluation process and, by extension, the results. It is also difficult to ascertain whether the students might have obtained similar results through traditional methods of phonological training. However, the systematic observation of students throughout the experiment, as well as similar previous experiments, indicates that in at



least one respect, namely in terms of learning motivation and engagement with the task, using interactive whiteboards and, by extension, technologies in general, is superior to other methods that could produce similar results. Another significant aspect, from a teacher's point of view, is

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the ease with which support materials for learning can be made. The integration of Jamboard application with Google Chrome allows for the rapid creation of engaging teaching materials, activities which would otherwise be time and resource consuming.

We consider that the results presented in this study are sufficient proof of the benefits of using interactive whiteboards to enhance literacy skills. They can also be used successfully in various educational contexts to motivate students with mental disabilities to learn and to engage them with the learning task. The presented program can be extended and improved to include other activities aimed at developing reading skills. It is important to create these activities based on the interests of students in order to enhance their participation in their own education and to also increase their autonomy in a highly digitized world.

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