

EXPLORING THE EFFECTS OF COMPUTER SOFTWARE FOR TEACHING READING AND WRITING SKILLS IN YOUNG CHILDREN

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Short Title: Teach Reading and Writing by a Computer Software

Abstract

This article describes computer software for teaching reading and writing skills grounded on theoretical principles that promote motivating, self-initiated and discovery learning. This software is based on error-free learning and allows children to explore textual material successfully without the need for prior reading and writing skills. Twenty children aged four and five were divided into an experimental group and a control group. Their reading and writing skills were assessed at the initial stage, at the end of the intervention and one year later. The results showed clear differences between the initial and end-of-intervention assessments. The computer training positively influenced the children's reading and writing skills. The assessment one year later, by which time all the participants had received formal reading and writing instruction, does not display such differences. This software may be a way of forestalling reading and writing problems in children at risk.

Keywords: Early Literacy, Reading and Writing Development, Multimedia Program, Discovery Learning, Reading, and Writing Skills.

Introduction

Reading and writing are one of the most important goals in primary education. Poor reading and writing affects learning in other academic subjects and it has cognitive, behavioural and motivational consequences that slow the development of other cognitive skills (McCardle, Scarborough and Catts, 2001; Alamargot and Fayol, 2009). Some pupils with special educational needs related to their intellectual disability, motor disability, autism or other disabilities, have great difficulty in developing reading and writing skills (Conti-Ramsden and Botting, 1999; Boudreau, 2002), although there are also other children at school with learning difficulties or who find it difficult to keep up the same learning pace as their classmates –whether or not they have any disabilities- who have great difficulty in learning to read and write. One of the main reasons why pupils fail to acquire these skills may be that they do not properly understand the instructional activities that they are asked to perform and therefore have limited interest in tasks related to reading and writing. On the other hand, it is hard for pupils with severe cognitive difficulties to benefit from traditional teaching, as it limits their activities with restrictions imposed by the teacher and fails to provide them with opportunities for active, self-directed learning (Valsiner, 1987).

According to Vygotskian theses on the social origin of higher psychological processes, a large part of the learning children do as they develop is due to the interaction in which they engage with adults or more expert peers who facilitate knowledge construction (Vygotsky, 1978; Edwards and Mercer, 1987; Rogoff, 1990, 1998; Cole, 1996; Cole, Engeström and Vásquez, 2002; Tomasello, 1999, Tomasello and Slobin, 2005). According to these authors, children learn by taking part in interactions often characterised by the absence of formal instruction in natural situations. Children begin learning to read and write before formal instruction begins at school. We agree with Burns, Griffin and Snow (1999), Teberosky (2001) and Ferreiro (2001), among others that children have early writing and reading skills before formal instruction begins at school. They acquire these skills in the process of mutual interaction with more expert people.

In spite of this, however, many children fail when it comes to formally learning to read and write. When pupils are taught to read and write, they need to be involved in learning experiences to which they can attribute meaning and of which they can make sense (Sole, 1992, Teberosky, 1997). We might say that IRA sequences (initiation by the adult, response by the child and assessment by the adult) can be found in formal teaching and learning situations at school (Hicks, 1995). Such sequences, which are frequently encountered in formal instructional contexts in the school setting, may be adequate when the pupils understand the tasks and have suitable resources to tackle them. However, in the early stages of learning, they may be inappropriate for pupils with difficulties, as they do not allow them to initiate communicative sequences and the teachers tend

to put a lot of pressure on the children in regard to assessment of their performance. Practices such as Bruner's storybook reading (1983) allow for much more open-ended and negotiable IRA sequences in which the adult's intervention in the zone of proximal development (ZPD) fosters the learning of new skills (De Loache and Brown, 1987, Schaffer, 1992).

Several multimedia computer programs for the teaching and learning of written language have been produced on the basis of the principles described above. Various Swedish studies (Heimann, Nelson, Tjus and Gillberg, 1995; Tjus, Heimann and Nelson, 1998a,b) have reported positive results using *Alfa* (Nelson and Prinz, 1991), a program for the old Apple II computers, and *Delta Messages* (Nelson and Heimann, 1995), an improved version of *Alfa*, for Macintosh computers, which was adapted to Catalan and Castilian (Nelson, Heimann and Aguilar, 1996), and empirically evaluated (Reyes, Basil and Rosell, 2000; Basil and Reyes, 2003). The pupils with which the efficacy of this software was assessed had special educational needs related to autism, deafness, cerebral palsy and mental retardation and in every case the educational intervention aimed at getting them to learn to read and write benefited from the use of the program in question. The children who took part in the research made progress in relation to the contents of the evaluated programs and also showed improvement in their reading and writing skills as measured by tests external to the programs. More recently, the *Omega* program has been developed (Heimann, Lundälv, Tjus and Nelson, 2004) which, like the *Alfa* and *Delta Messages* programs before it, is aimed at children with special educational needs.

These programs have provided fundamental experience for the design and production of a new multimedia program called Divertext. This software is grounded on theoretical principles that promote motivating, self-starting, discovery learning and it has been produced for teaching reading and writing skills to pupils with disabilities (Reyes and Basil, 2008). This software is based on error-free learning and allows children to explore textual material successfully without the need for prior reading and writing skills. This is very important especially for children with special needs that are used to fail in other traditional methods of learning (Foley, 1993; Sandberg and Hjelmquist, 1996). Like its predecessors, *Delta Messages* (Nelson and Heimann, 1995) and *Omega* (Heimann, Lundälv, Tjus and Nelson, 2004), this software has been produced with a view to providing effective tools for helping children with special educational needs to develop good literacy skills. Reyes and Basil (2008) has demonstrated the effectiveness of Divertext with pupils with intellectual disability. In her study tasks were based upon the need to develop literacy activities that were meaningful from the very beginning to students showing severe learning disabilities in the area of written language. Divertext design allowed the students to learn without being pressured by corrective feedback and offered them the opportunity for extensive practice. Also, Suárez (2005) studied the case of a child with serious speech and motor difficulties who was helped to learn to read and write using the Divertext program.

Certainly, there is a need for research that evaluates the effectiveness of multimedia software in learning to read and write in the case of both children with difficulties and normative populations, since this is a high priority area within the curriculum in every country. Studies of computer software have shown its potential to enhance reading and writing in children with reading difficulties (Olson, Wise, Ring and Johnson, 1997; Dimitriadi, 2001) and children with disabilities (Heimann, Nelson, Tjus and Gillberg, 1995; Tjus, Heimann and Nelson, 1998a,b; Hetzroni and Schanin, 2002; Basil and Reyes, 2003; Reyes, Basil and Rosell, 2000), but few have examined its use with very young children.

Research on emergent literacy has shown that interactive storybooks on a computer enable children beginning to read to improve their vocabulary (Segers and Verhoeven, 2002; Verhallen, Bus and de Jong, 2006; Korat, 2010), metalinguistic awareness (Reitsma and Wesseling, 1998) and text comprehension (Miller, Blackstock and Miller, 1994; Korat, 2010), and also promote phonological awareness (Chera and Wood, 2003). It has also been found that children just starting to read benefit from talking books with accompanying text and reinforcement activities (Lewin, 2000; de Jong and Bus, 2002). It has also been reported that kindergarten children at risk benefit from multimedia stories in relation to language skills and narrative comprehension (Verhallen, Bus and de Jong, 2006) and also have positive effects on immigrant children (Verhallen and Bus, 2010) or in young children from low socioeconomic status who are at risk for reading failure (De Jong and Bus, 2004). In addition, we also have found some studies reporting that when e-books are used for very young children (pre-kindergarten) the positive effects for comprehension outcomes are from moderate to small (Zucker, Moody and McKenna, 2009). These results point to a need for more research to analyze more carefully the benefit of these e-books that support early literacy learning in young children as some authors have begun to carry out (Roskos, Bruek and Widman, 2009).

The aim of the present study was to examine whether this multimedia software (Divertext) can promote reading and writing acquisition in young children. We predicted that this software, which has been successful in aiding children with serious development disorders in learning to read and write (Reyes and Basil, 2008), might also be useful for promoting reading and writing experiences in children of infant school age who have not had any experience of formal instruction for such a purpose and thereby motivate and prepare them to learn such things better.

Program Design

Divertext is a multimedia program that gives pupils the chance to explore written texts and oral language in an entertaining way. The object of the program is to improve pupils' reading and writing competences, and to boost their motivation in regard to both written and oral language. This software, like its predecessors, *Delta Messages* (Nelson and Heimann, 1995) and *Omega* (Heimann, Lundälv, Tjus and Nelson, 2004), has two operational modes: learning activities and testing activities. When working on the learning activities, pupils freely choose syntagms to form phrases, syllables to form words, or letters to form words, from the various options appearing on the computer screen. The options that appear are designed in such a way that whatever the pupil's choice, the result is always a phrase or word with meaning represented by animations or photographs, text and digitised speech (as shown in Fig. 1).

(Insert Fig. 1 here: Example of a learning activity from lesson 10 of the "Animated Cartoon Lessons" block)

The test activities operate in reverse order: when a phrase or a word appears on the screen, the pupil has to choose the

syntagms, syllables or letters that make it up.

The tasks set by the program allow pupils to “read and write” meaningful phrases and words even when their reading and writing skills are extremely poor. The Divertext activities let pupils combine global reading and writing strategies with analytical strategies so that the functional aspects of writing are given priority over formal aspects. This is the main innovation in the Divertext program compared to its predecessors, *Alfa* (Nelson and Prinz, 1991), *Delta Messages* (Nelson and Heimann, 1995), and *Omega* (Heimann, Lundälv, Tjus and Nelson, 2004), which operated only in accordance with a strategy of reading whole words.

It must be borne in mind that using Divertext is not an alternative to the traditional methods habitually employed in the classroom, but rather a way of complementing or supplementing them. It should be stressed, also, that the part played by the teacher or tutor in the individual Divertext sessions is of great importance, as she has to accompany the pupils in their activities and improve their learning by providing them with suitable help and reacting to the various self-initiated activities with repetitions, expansions and comments of various kinds on what they say and write.

The Divertext software consists of 30 lessons, including activities of different kinds and with different contents, grouped into three big blocks: 12 animated cartoon lessons, 2 story lessons and 16 photo lessons. The cartoon lessons focus on writing simple phrases, such as “the potato washes the computer” (see Fig. 1), by selecting syntagms and verbs. The syntactic structures employed make use of rhymes and alliterations to develop phonological awareness while gradually increasing the complexity of the syntax. This activity enables pupils to write a total of 81 different sentences.

The story activities diversify and broaden the preceding contents, as they operate at the level of complex phrases with more than one core and allow users to write a total of 54 different short stories such as “*La serp, peluda i somrient, escala la muntanya i es menja una poma*” (The smiling hairy snake climbs the mountain and eats an apple). An example is shown in Fig. 2.

(Insert Fig.2 here)

As can be seen in Figure 2, the pupil had three phrases on the screen to choose from and has chosen “*La serp peluda i somrient*” (The smiling hairy snake). His choice has been written out, read out in a digitalised voice and represented by an image (screen 2). On the second screen, the child is again given three choices. This time he clicks on “*escala la muntanya*” (climbs the mountain), so that on the third screen the phrase is written out, read out in a digitalised voice and represented by an image. On the third screen the pupil is again presented with three choices and picks the first, so that on the fourth screen the phrase “*i es menja una poma*” (and eats an apple), is read out and represented. The story has now been written and the child can now turn over the pages, corresponding to screens 5, 6 and 7.

The photo activities allow users to write a total of 200 carefully chosen words by selecting syllables and letters. The options presented have been designed so that whichever one the pupil chooses, the result is always a word with meaning that will be read out loud in a digitalised voice and represented by a photograph. An example is shown in Fig. 3.

(Insert Fig. 3 here)

As can be seen in this example, the pupil can choose by the last letter (in this case “*nas*” – nose) or by the last syllable (in the second case “*puma*” - puma) so that, whichever choice he makes, he will always write a meaningful word that will be read out loud in a digitalised voice and represented by a photograph.

During the learning activities (cartoons, stories and photos) the pupil receives immediate multichannel feedback (via the voice, image and text) to their self initiated productions. On the test activities, however, they are explicitly told whether the answer is right or not. In the case of an incorrect answer, the items re-appear on the screen with the right answer shaded in grey. If, on the other hand, the answer is correct, the pupil receives a gift accompanied by a sound (for example, a dancing skeleton or a waiter playing the drums).

Method

Participants

Twenty children from a mainstream school in Barcelona (Spain), in their second year of infants’ school, participated in the study. The children were divided into two groups, an experimental group consisting of 6 girls and 4 boys, and a control group consisting of 7 girls and 3 boys, with a chronological age between 4:3 and 5:3 years ($M=55.1$ months; $SD=3.14$). All participants were white with a medium-high economic level.

Procedure

Following an initial assessment, the pupils in the experimental group used the Divertext computer program in individual 30-minute instruction sessions twice a week for three and a half months (approximately 28 sessions in all). The school calendar determined the period of intervention with the program. The control group did not receive any instruction sessions with the Divertext program. All the participants, in both the experimental group and the control group, continued to take part in the normal classroom teaching and learning activities throughout the research period.

The participants’ reading and writing skills were assessed at three different times: (i) at the beginning of the study (Pre-test); (ii) one week after finishing the instruction (Post-test) and (iii) one year after finishing the instruction (Follow-up period).

Measurements

Prior to the introduction of the Divertext software, none of the pupils had received formal reading and writing instruction.

Three types of measurements were made in order to analyse the results of using the software:

- Progress through the lessons as measured by the number of lessons successfully completed using a criterion of 80% correct answers (experimental group only).
- Assessment by means of specific tests based on Divertext vocabulary (both groups).
- Assessment by means of specific tests based on non-Divertext vocabulary (both groups).

The specific tests based on Divertext vocabulary were as follows:

Oral Comprehension: A word was said out loud and the subject had to find the corresponding photograph. (16 words).

Reading Words: The subject was given a printed word and had to find the corresponding photograph. (16 words)

Written Dictation: A word was dictated to the pupil and the pupil had to write it down. (16 words).

Reading Phrases: The pupil was given a printed phrase and had to find the corresponding picture sheet choosing among three options. (3 phrases)

Image Writing: The pupil was given a picture sheet and had to write what it represented (3 images).

The specific tests based on non-Divertext vocabulary were as follows:

Reading Letters: The pupil had to identify each of the letters in the alphabet.

Phonological Synthesis: Pupils were asked to point to the photograph corresponding to a word pronounced phoneme by phoneme. The 10 words were dictated one at a time with the person doing the dictating waiting for the pupil to finish responding to one word before going on to the next.

Phonological Syllable Segmentation: Pupils were asked to knock on the table as many times as there were syllables in a word. Ten words were dictated one at a time with the person doing the dictating waiting for the pupil to respond to one before going on to the next.

Written Dictation with Non-Divertext Words: Pupils were asked to write down a total of 10 words that were dictated to them. The person doing the dictating waited for them to finish one word before dictating the next one.

These tests were designed ad-hoc for this research and it were inspired by those used in previous research suggested by Dahlgren and Hjelmquist (1996), Basil (1998) and Reyes, Basil and Rosell (2000) that has shown these tests were reliable. In the current study these tests showed high internal consistency (Cronbach's alphas of at least 0.88).

Results

Progress on the Divertext Lessons

All of children in the experimental group made considerable progress on the Divertext program from the beginning (Pre-test) to the end of the training (Post-test) as presented in Table 1. As a group, the pupils completed an average of 11.6 of the 12 animated cartoon lessons in the program and 4.5 of the 8 lessons in the first photos set (Photos 1). The pupils did not start either the story lessons or the second set of photo lessons (Photos 2).

Table 1:

Number of Divertext Lessons covered from start to Post-test

	Pre-test (Average Score (standard deviation))	Post-test (Average Score (standard deviation))
Animated Cartoon (max=12)	2.20 (0.41)	11.6 (0.84)
Photo 1 (max=8)	0.50 (0.52)	4.50 (1.26)

The pupils learnt words and simple grammatical structures depending on the different types of exercises they worked on.

Assessment using Specific Tests based on Divertext Vocabulary

No significant differences were found between the control and experimental groups on any of the variables studied in the pre-test, with the exception of the "reading letters" variable, which we shall discuss later on. The results in regard to each of the variables studied and the results of the comparison between the experimental group and the control group on the post-test, where there were significant differences, can be seen in Table 2.

Oral Comprehension

There were no differences between the control and experimental groups on this variable.

Reading Words

There were no significant differences between the control and the experimental group on the pre-test. A clearly significant difference, ($t(10.12)=5.02, p=.001$) was found between the control and the experimental group on the post-test. Whereas the control group's score only increased by an average of 1.7 between the pre-test and the post-test ($t(9)=-3.59, p>.005$), the experimental group's score increased significantly by an average of 7.2 ($t(9)=-5.54, p=.000$). On the basis of this result, we can assume that the computer training positively influenced the children's ability to read words. In Table 2, the average scores and standard deviations for both groups are presented as well as t -test results.

Written Dictation

A clearly significant difference ($t(9)=4.26, p=.002$), was found between the control and the experimental group on the post-test, as can be seen in Table 2. A t -test also revealed a significant change between the average scores at pre- versus post-test in the experimental group ($t(9)=-4.32, p=.002$).

One-syllable words were considered to be acceptably written if they contained 50% of the letters in the model (or 50% + 1 if the model had an uneven number of letters) and the number of letters was the same as in the model (± 1). Words comprising two or more syllables were considered acceptable if they comprised any combination containing 50% of the letters in the model (or 50% + 1 if the model had an uneven number of letters), the same number of syllables as the model (± 1) and at least two letters in the correct syllabic order.

Some examples from the written dictation are presented in Fig. 4.

(Inser Fig.4 here)

As can be seen, at the initial assessment Subject 3 of the experimental group writes vowels, or vowels without any consonants, without any match to the word he is supposed to write. However, at the final assessment he writes the words almost correctly. By contrast, although the score of Subject 12 of the control group is very similar to that of the subject from

the control group at the initial assessment, on the final assessment she is still writing consonants and vowels without any relation to the word he is supposed to write. Similar results were obtained with the other subjects.

Reading Phrases

There are no significant differences between the control and the experimental group on the pre-test. A clearly significant difference, ($t(12.5) = 2.95, p = .01$) was found between the control and the experimental group on the post-test, as seen in Table 2. A t -test also revealed a significant change between the average scores at pre- versus post-test in the experimental group ($t(9) = -4.12, p = .003$). It should be pointed out that most of the subjects did not read the whole phrase, but identified one of the words and related it to the corresponding photograph.

Image Writing

No statistically significant differences were found between the two groups on this variable, although certain qualitative differences were observed. Some examples from image writing are presented in Fig. 5. As can be seen in Fig. 5, when, at the initial assessment, the subject from the experimental group is asked to write a sentence representing the image, she says three phrases out loud (there is a snake, it is daytime and he has an apple) and writes them on separate lines, but the words she actually writes fail to match the words she wants to write. On the other hand, at the final assessment, this child does write the words she utters orally, although she does not separate words when writing phrases or sentences.

By contrast, at the initial assessment the subject from the control group describes orally the items he sees in the drawing (apple, sun, mountain, snake) and represents them with a letter lacking phonemic correspondence. By the final assessment he is able to say the phrase out loud (*“Una serpiente que a la cual le está enganchada una manzana”* - a snake with an apple stuck to its tail), but when he comes to write it, although he uses more letters, these fail to match his oral utterance.

(Insert Fig.5 here)

Assessment using Specific Tests based on Non-Divertext Vocabulary

Reading Letters

Both groups identified more letters in the alphabet in the post-test than in the pre-test. At the initial assessment (see Table 2) the average number of letters identified by subjects in the control group was 1.7, whereas the average for the experimental group was 3.4. At the final assessment, the average number of letters identified by subjects in the control group was 7.00, while the average for the experimental group was 12.8. This difference is significant ($t(18) = 2.81, p = .01$).

Since there is an increase in the number of letters of the alphabet recognised by both groups on the post-test, we analysed the difference in the scores of each subject between the pre-test and the post-test using the mean difference statistical test. The mean difference between the experimental group (Mean=9.6, SD=4.81) and the control group (Mean=5.6, SD=4.11) is statistically significant ($t(18) = 2.14, p = .04$), as can be seen in Fig. 6. According to these results, we can assume that the computer training positively influenced the children's ability to read letters.

(Insert Fig.6 here)

Phonological Synthesis

Both groups improve their ability to identify photographs corresponding to the words pronounced phoneme by phoneme. However, as can be seen in Table 2, subjects in the experimental group perform better than the control group on this variable and this difference is significant ($t(13) = 2.38, p = .033$).

Phonological Syllable Segmentation

There were significant differences between the experimental group and the control group on this variable on the post-test, $t(18) = 2.11, p = .04$. (see Table 2). The control group's score increased by an average of 1.2 between the pre-test and the post-test ($t(9) = -6, p = .000$), whereas the experimental group's score increased significantly by an average of 2.7 ($t(9) = -7.3, p = .000$). According to these results, we can assume that both groups improve their phonological syllable segmentation, although our results showed that the computer training positively influenced the children's phonological syllable segmentation.

Writing Non-Divertext Words

A clearly significant difference, $t(9.25) = 4.10, p = .002$, was found between the control group and the experimental group on the post-test. In the pre-test, none of the subjects was able to write correctly any of the words presented to them. In the post-test, however, the subjects in the experimental group showed significant progress in writing such words. A t -test revealed a significant change between the average scores at pre- versus post-test in the experimental group ($t(9) = -4.25, p = .002$). Some examples of the writing non-Divertext words are given in Fig. 7.

(Insert Fig. 7 here)

As can be seen in Fig. 7, the experimental group subject made considerable progress in writing words. Whereas at the initial assessment she practically did not use letters (except those in her own name, Laia), by the final assessment she was writing words almost correctly. In the case of the control group subject, on the other hand, there was no difference between his initial and final writing performance. At both times the vowels and consonants he wrote completely failed to match the words he was supposed to write.

Follow-up Period

The assessment one year later, by which time all the participants had received formal reading and writing instruction, did not display any significant statistical differences between the control and the experimental group. A t -test was applied but it was not significant.

The assessment one year later, by which time all the participants had formally received reading and writing instruction, did not display any significant statistical differences between the control and the experimental group. We applied a t -test but the results were not statistically significant.

Discussion

The results of this study support the hypothesis that intervention with the Divertext multimedia program (Reyes and Basil, 2008) can stimulate the learning of reading and writing in infant school children who have not had any experience of formal instructional for such purposes. The results showed clear differences between the initial and end-of-intervention assessments for the experimental group. All the pupils made very considerable progress with the program, despite the short intervention time.

The results show improvements in relation to reading words, writing words -both related and unrelated to the program-, reading phrases and reading letters. It was also found that both the control and experimental group subjects improved their performance on the tasks involving phonological synthesis and phonologically segmenting words into syllables, although the experimental group subjects, who had used the Divertext program, did so to a greater extent. These results indicate, as Hester & Hodson (2004) have noted, that children have syllable segmentation skills long before they acquire any knowledge of spelling or the alphabet. These results agree with the findings by Chera and Wood (2003) using animated multimedia “talking books” to promote phonological awareness in children beginning to read.

The positive effects of the program may be due to the interactive and motivating nature of the interactive medium which promotes active, self-directed learning, and the fact that the Divertext program (Reyes and Basil, 2008) recreates a natural teaching environment which provides contingent reactions by the adult to the pupil-initiated activities. An adult interacting with the child plays an important role in facilitating the child’s learning to read and write syllables, letters, words and phrases. This view is based on a developmental approach according to which the adult acts in the zone of proximal development (Vygotsky, 1978) by expanding the child’s responses, attracting the child’s attention to particular features, trying to link up with previous items of knowledge, etc.

On the other hand, it has been argued that in the early stages of learning to read, there are two routes to beginning word recognition: a) the logographic route - reading whole words and b) the alphabetic or phonic route – decoding using letter-to-sound conversion. The fact that the Divertext activities allow pupils to combine global reading and writing strategies with analytical strategies facilitates the learning of reading and writing by children whichever of these two routes they follow in the main.

Our results agree with research on early literacy that has shown that multimedia programs can produce positive reading and writing learning effects in very young children.

The results of the assessment after a year, by which time all the children had been taught to read and write, do not show any significant differences between the control group and the experimental group. When the sample was chosen, all the children were of normal development, without any apparent cognitive, attention or memory problems. It was therefore to be expected that they would respond positively to formal instruction in reading and writing. Our results agree with the research by Heimann, Nelson, Tjus and Gillberg (1995) in which they also used the Delta Messages program with a group of normally developing children before and after they learned to read and write.

Since the children without any prior experience of formal reading and writing instruction who used Divertext in this study made significant progress on reading and writing tasks, this suggests that the program may be also useful for children with reading disabilities or for struggling readers. We suggest this software be used to complement the formal classroom activities the children carry out to help children to learn to read and write. If teachers familiarise themselves with the program and get to know its features they will be able to choose whether to use it only with certain children or with all of them on some everyday classroom activities to foster motivation in relation to reading and writing, yet further research is needed to test these possibilities.

Other future projects should examine the effectiveness of the software with more participants and with a longer intervention period.

References

- Alamargot D and Fayol M (2009). Modelling the development of written composition. In Beard R, Myhill D, Nystrand M, Riley J (Eds.), *Writing Development*. Sage, United Kingdom, pp. 23-47.
- Basil C (1998). Técnicas de enseñanza de lectura y escritura en alumnos con problemas graves de motricidad y habla [Techniques for teaching reading and writing to children with severe motor and speech disabilities]. In Basil C, Soro-Camats E and Rosell C (eds.) *Sistemas de signos y ayudas técnicas para la comunicación aumentativa y la escritura* [Sign systems and technical aids for augmentative communication and writing]. Masson, Barcelona.
- Basil C and Reyes S (2003). Acquisition of literacy skills by children with severe disability. *Child lang. Teach. Ther.* 19: 27-48.
- Boudreau D (2002). Literacy skills in children and adolescents with Down Syndrome. *Reading and writing.* 15 (5-6): 497-525.
- Bruner JS (1983). *Child’s talk*. Oxford University Press, Oxford.
- Burns MS, Griffin P and Snow CE (Eds.) (1999). *Starting out right: A guide to promoting children’s reading success*. National Academy Press, Washington.
- Chera P and Wood C (2003). Animated multimedia “talking books” can promote phonological awareness in children beginning to read. *Learn. Instr.* 13 (1): 33-52.
- Cole M (1999). *Psicología cultural* [Cultural Psychology]. Original publication in English; 1996 Madrid: Morata.
- Cole M, Engeström Y and Vásquez O (2002). *Mente, cultura y actividad* [Mind, Culture and Activity]. Oxford University Press, Mexico.
- Conti-Ramsden G and Botting N (1999). Classification of children with Specific Language Impairment. *J. Speech Lang. Hear. Res.* 42: 1195-1204.

- Dahlgren A and Hjelmquist E (1996). Phonological awareness and literacy in nonspeaking preschool children with cerebral palsy. *Augment. Altern. Commun.* 12(3): 138-153.
- De Jong MT and Bus AG (2002). Quality of book-reading matters for early readers: An experiment with the same book in a regular or electronic format. *J. Educ. Psychol.* 94: 145-155.
- De Jong MT and Bus AG (2004). The efficacy of electronic books in fostering kindergarten children's emergent story understanding. *Read. Res. Q.* 39: 378-393.
- DeLoache JS and Brown AL (1987). The early emergence of planning skills. In Bruner J and Haste H (eds). *Making sense: The child's construction of the worlds.* Methuen, New York, pp.108-130.
- Dimitriadi Y (2001). Evaluating the use of multimedia authoring with dyslexic learners: A case study. *Br. J. Educ. Technol.* 32 (3): 265-275.
- Edwards D and Mercer N (1988). *El conocimiento compartido: El desarrollo de la comprensión en el aula.* [Common Knowledge: The development of understanding in the classroom]. Paidós, Barcelona.
- Ferreiro E (2001). *Pasado y presente de los verbos leer y escribir* [Past and present of the verbs to read and write]. Fondo de cultura económica de Argentina, Buenos Aires.
- Foley BE. (1993). The development of literacy in individuals with severe congenital speech and motor impairment. *Top. Lang. Disord.* 13: 16-32.
- Heimann M, Nelson KE, Tjus T and Gillberg C (1995). Increasing reading and communication skills in children with autism through an interactive multimedia computer program. *J. Autism Develop. Disord.* 25: 459-480.
- Heimann M, Lundälv M, Tjus T and Nelson K (2004). *Omega* (Software multimedia). SuperImpact Images Inc, Gothenburg.
- Hester E and Hodson BW (2004). The role of phonological representation in decoding skills of young readers. *Child Lang. Teach. Ther.* 20 (2): 115-133.
- Hetzroni OE and Schanin M (2002). Emergent literacy in children with severe disabilities using interactive multimedia stories. *J. Develop. Phys. Disabil.* 14 (2): 173-190.
- Hicks D (1995). Discourse, learning and teaching. *Review of Research in Education.* 21: 49-95.
- Korat O (2010). Reading electronic books as a support for vocabulary, story comprehension and word reading in kindergarten and first grade. *Comput. Educ.* 55: 24-31.
- Lewin C (2000). Exploring the effects of talking book software in UK primary classrooms. *J. Res. Read.* 23: 149-157.
- McCardle P, Scarborough HS and Catts HW (2001). Predicting, explaining and preventing children's reading difficulties. *Learning Disabil. Research Practice.* 16: 230-239.
- Miller L, Blackstock J and Miller R (1994). An exploratory study into the use of cd-rom storybooks. *Comput. Educ.* 22: 187-204.
- Nelson KE and Prinz PM (1991). *Alpha interactive language series / Gator super sentences* (Computer software). Warriors Mark, PA: Super Impact Images.
- Nelson KE and Heimann M (1995). *Delta Messages - a multimedia program for language learning* (software multimedia) Warriors Mark, PA: Super Impact Images, Topic Dos Hb, Gothenburg, Sweden.
- Nelson KE, Heimann M and Aguilar A (1996). *Delta Messages: versió en català i castellà* [Delta Messages: version in Catalan and Castilian]. (Multimedia software, experimental version). Unitat de Tècniques Augmentatives de Comunicació [Augmentative Communication Techniques Unit], Barcelona.
- Olson B, Wise J, Ring J, Johnson M (1997). Computer-based remedial training in phoneme awareness and phonological decoding: effects on the post training development of word recognition. *Sci. Stud. Read.* 1: 235-253.
- Reitsma P and Wesseling R (1998). Effects of computer-assisted training of blending skills in kindergartners. *Sci. Stud. Read.* 2 (4): 301-320.
- Reyes S and Basil C (2008). *Disseny i avaluació del Divertext, un programari per a l'alfabetització inicial d'alumnes amb necessitats educatives especial.* [Development and Evaluation of Divertext, Multimedia Software for Early Literacy to students with Special Education Needs]. *Suports.* 12 (2): 84-95.
- Reyes S, Basil C and Rosell C (2000). *Avaluació del programa multimedia Delta per a l'aprenentatge de la lectura i l'escriptura en alumnes amb discapacitats: una experiència d'ensenyament autoiniciat i motivador* [An evaluation of the Delta multimedia program for learning to read and write in regard to pupils with disabilities: a self-starting and motivating educational experiment]. *Suports.* 4 (1): 51-65.
- Rogoff B (1990). *Apprenticeship in thinking: Cognitive development in social context.* Oxford University Press, New York.
- Rogoff B (1998). Cognition as collaborative process. In Jun D and Siegler RS (eds. Vol. 2), *Cognition, perception and Language,* Damon W. (editor-in-chief), *Handbook Child Psychol.* Wiley, New York, pp. 679-744.
- Roskos K, Brueck J and Widman S (2009). Investigating analytic tools for e-book design in early Literacy learning. *J. Interact. Online Learn.* 8. Retrieved from: <http://www.ncolr.org/jiol/issues/PDF/8.3.3.pdf>
- Sandberg AD and Hjelmquist E (1996). Phonological awareness and literacy in nonspeaking preschool children with cerebral palsy. *Augment. Altern. Commun.* 12: 138-153.
- Schaffer HR (1992). Joint involvement episodes as context for development. In McGurk H (ed.) *Childhood social development.* Lawrence Erlbaum, Hove, pp. 99-129.
- Segers E and Verhoeven L (2002). Multimedia support of early literacy learning. *Comput. Educ.* 39: 207-221
- Solé I (1992). *Estrategias de lectura* [Reading Strategies]. Graó, Barcelona.
- Suárez MD (2005). *Adquisición de la lectura y la escritura en alumnos con graves dificultades de habla y motricidad. Estudio de caso.* [The acquisition of reading and writing by pupils with severe speech and motor difficulties. A case study]. *Comunicación y Pedagogía.* 25: 54-58.

- Teberosky A (1997). Aprenentatge i ensenyament de l'escriptura [Learning and teaching writing]. In. Solé I (Coord.), Psicopedagogia de la lectura i l'escriptura [The Psychopedagogy of Reading and Writing]. UOC, Barcelona.
- Teberosky A (2001). Proposta constructivista per aprendre a llegir i escriure [A constructivist proposal for learning to read and write]. Vicens Vives, Barcelona.
- Tjus T, Heimann M and Nelson KE (1998a). Gains in literacy through the use of a specially developed multimedia computer strategy: Positive findings from 13 children with autism. *Autism: The International J. Res. Pract.* 2: 139-156.
- Tjus T, Heimann M and Nelson KE (1998b). Reading acquisition by implementing a multimedia intervention strategy for fifty children with learning and communication disabilities. In Tjus T (ed.) *Language and literacy acquisition in children with developmental and learning disabilities (Study III Gothenburg, University of Gothenburg, pp. 1-27.*
- Tomasello M (1999). *The cultural origins of human cognition.* Harvard University Press, Cambridge.
- Tomasello M and Slobin DI (2005). *Beyond nature-nurture: essays in honor of Elisabeth Bates.* Lawrence Erlbaum Associates Publishers, Mahwah.
- Valsiner J (1987). *Culture and the development of children's action.* Wiley, New York.
- Verhallen MJ, Bus A and de Jong M (2006). The promise of multimedia stories for kindergarten children at risk. *J. Educ. Psychol.* 98 (2): 410-419.
- Verhallen MJ and Bus A (2010). Low-Income Immigrant pupils learning vocabulary through digital Picture Storybooks. *J. Educ. Psychol.* 102 (1): 54-61.
- Vygotsky LS (1978). *Mind and Society. The development of higher psychological processes.* Harvard University Press, Cambridge.
- Zucker T, Moody A and Mckenna M (2009). The effects of electronic books on Prekindergarten to grade 5 students' literacy and language outcomes: A research synthesis. *J. Educ. Comput. Res.* 40: 47-87.

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Figure Captions

Fig.1: Example of a learning activity from lesson 10 of the “Animated Cartoon lessons” block.

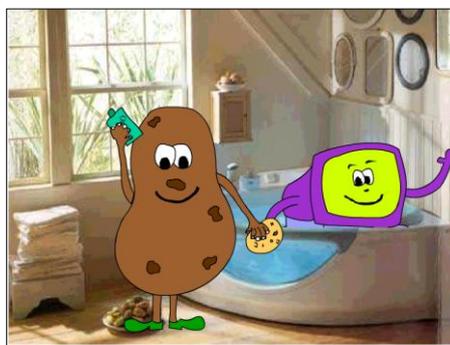


Fig.2: Examples of a learning activity from lesson 14 in the “story activities” block.

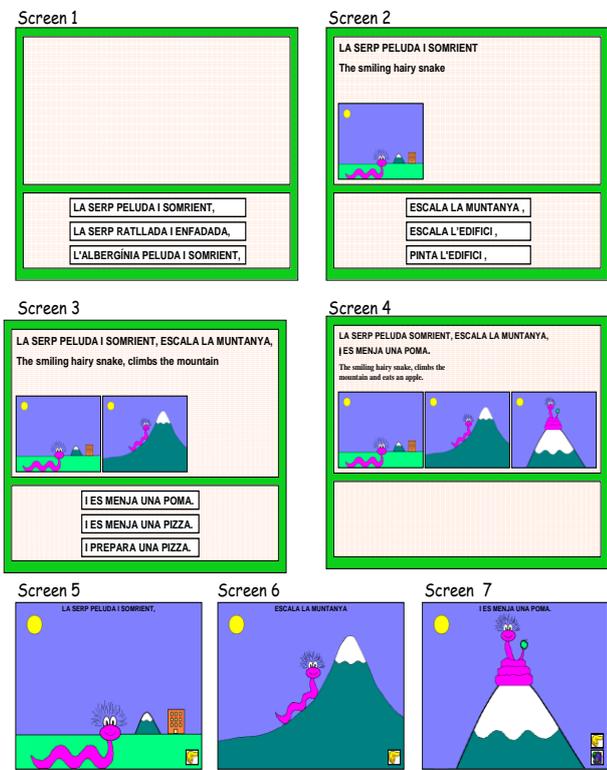


Fig.3. Examples of two learning activities from the photo lessons block.

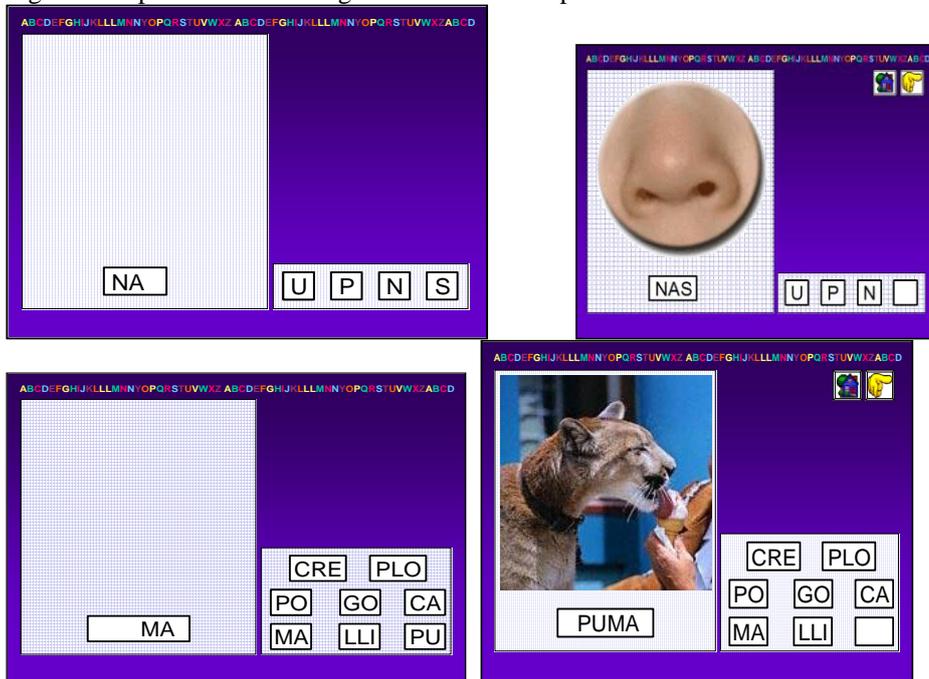


Fig. 4. Examples of written dictation by a subject from the experimental group and another from the control group.

(S₃, experimental group)

Initial Assessment	Final Assessment
.10 nou	OU (nou)
.21 pèsol	•PÈZVL (pèsol)
.10 sol	•SOL (sol)
.20 ploma	•PLOMA (ploma)
.A camell	•CAMELL (camell)
.A sofà	•SOFA (sofà)

(S₁₂, Control group)

Initial Assessment	Final Assessment
A (nou)	•ESC (nou)
•LAIA (pèsol)	•R (pèsol)
•R (sol)	•I (sol)
•ES (ploma)	•L (ploma)
•P# (camell)	•LAIL (camell)
•OI (sofà)	•LAIAO (sofà)

Fig.5.Examples of Image Writing by an experimental group subject and a control group subject.

Image writing

(S₂, Experimental group)

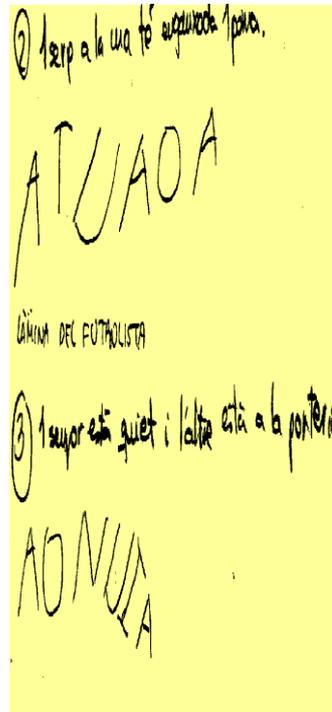
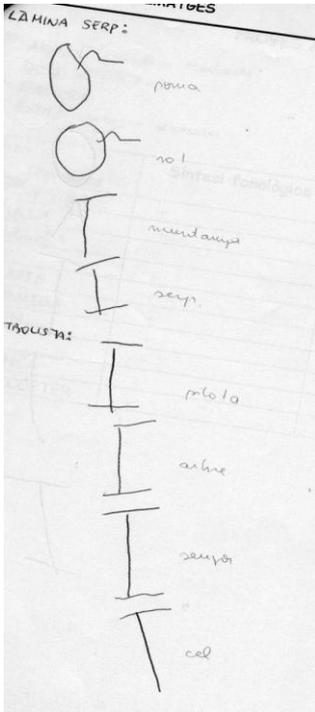
Initial Assessment	Final Assessment
<p>CAMINA DE LA SERP AIAAM (He ha una serp) PAM (És de dia) APA (Té una poma)</p> <p>HI HA UNA SERP. ÉS DE DIA. TÉ UNA POMA. There is a snake. It is daytime. He has an apple.</p>	<p>SERP UNASERP CAFILAAPARUMAMUTA A (Una serp muntanya per una muntanya)</p> <p>UNA SERP QUE S'ENFILA PER UNA MUNTANYA. A snake going up a mountain.</p>

Image writing

(S14, Control group)

Initial Assessment

Final Assessment



POMA, SOL, MUNTANYA, SERP. UNA SERP A LA CUA TÉ ENGANXADA UNA POMA.

Apple, sun, mountain, snake.

A snake with an apple stuck to its tail.

PILOTA, ARBRE, SENYOR, CEL. UN SENYOR ESTÀ QUIET I L'ALTRE A LA PORTERIA.

Balloon, tree, man, sky.

One man is still and the other is at the door.

Fig.6. Letter-reading results for the experimental group and the control group before and after intervention with Divertext

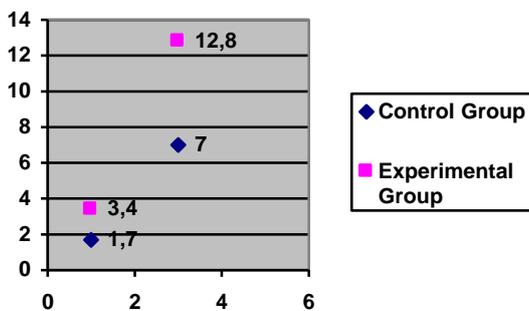
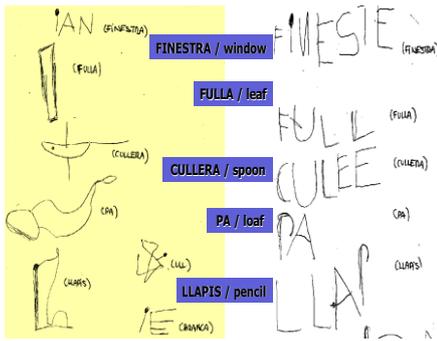


Fig. 7: Writing non-Divertext words at pre- and post-test in the experimental and control group.

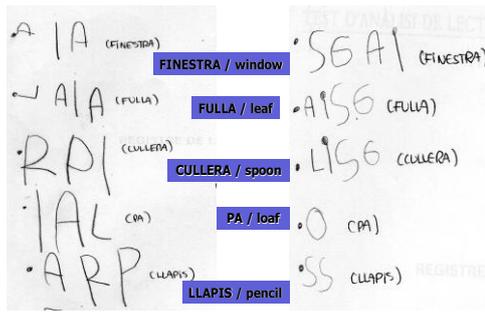
(S₃, experimental group)

Initial Assessment Final Assessment



(S₁₅, Control group)

Initial Assessment Final Assessment



Tables

Table 1:

	Pre-test (Average Score (standard deviation))	Post-test (Average Score (standard deviation))
Animated Cartoon (max=12)	2.20 (0.41)	11.6 (0.84)
Photo 1 (max=8)	0.50 (0.52)	4.50(1.26)

Table 1. Number of Divertext Lessons covered from start to Post-test

Table 2:

Test	Pre-test		Post-test		t-test	signification
	Average score	standart deviation	Average score	standart deviation		
<i>Oral Comprehension</i>						
Experimental Group	16	0	16	0	--	--
Control Group	16	0	16	0	--	--
<i>Reading Words</i>						
Experimental Group	3.1	2.60	10.3	4.39	$t(10.1)=5.02$	$p=.001$
Control Group	1.4	1.07	3.1	1.10		
<i>Written Dictation</i>						
Experimental Group	0	0	7.3	5.33	$t(9)=4.26$	$p=.002$
Control Group	0	0	0.10	0.31		
<i>Reading Phrases</i>						
Experimental Group	0.20	0.42	1.4	1.07	$t(12.5)=2.95$	$p=.01$
Control Group	0	0	0.30	0.48		
<i>Image Writing</i>						
Experimental Group	0	0	0.20	0.63	$t(9)=1$	$p=.34, n.s.$
Control Group	0	0	0	0		
<i>Reading letters</i>						
Experimental Group	3.4	1.64	12.8	5.18	$t(18)=2.81$	$p=.01$
Control Group	1.7	1.25	7	3.94		
<i>Phonological Synthesis</i>						
Experimental Group	7.5	3.1	9.6	0.69	$t(13)=2.38$	$p=.033$
Control Group	5.7	4	8.4	1.42		
<i>Phonological syllable segmentation</i>						
Experimental Group	6.1	1.85	8.8	1.47	$t(18)=2.11$	$p=.04$
Control Group	6.3	1.05	7.5	1.26		
<i>Written non-Divertext words</i>						
Experimental Group	0	0	3.6	2.67	$t(9.2)=4.10$	$p=.002$
Control Group	0	0	0.10	0.31		

Table 2: Scores at Pre- and Post-Test of Experimental and Control Group.

Biographical Note:

Rosa Vilaseca is a PhD. Professor at the University of Barcelona in the Developmental and Educational Department. She participated in several Masters from other Universities. She has participated in several research works in the following areas: language and communication development, language development delay, quality of life in families and children with disabilities, and more recently in teaching reading and writing skills with normal developmental children and with children with disabilities. She has published papers in international and national journals and at the same time she has collaborate in book's chapters as national as international ones.