

## An ICT-based Application to Support Deaf Children's Reading Comprehension

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### Abstract

*As several studies report, deaf children have specific literacy problems. In particular, they are poor readers, a fact that causes them difficulties in managing everyday activities. In our contribution we describe an ICT-based web application proposing children's stories and comprehension exercises, whose aim is to support deaf children's reading comprehension skills and, in particular, their understanding of the temporal relations between the events happening in the plot. Three are the innovative aspects of our proposal: the exploitation of ICT potential, the "ad hoc" text simplification and the game-like approach in order to create a didactic tool which meets deaf children's special needs. Giving that deaf children seem to be visual learners, we opted for an animated graphical presentation of the stories. We designed and developed our system following a user-centered design approach: deaf and hearing children, teachers, speech therapists and psychologists were involved during all the design process steps. An extensive evaluation session was organized at the Istituto dei Sordi of Torino. Deaf and hearing children had to read three stories: one in its original version (1), one in its simplified version (2) and one in its simplified and illustrated version (3). The goal of the experiment was to check if deaf children's understanding of the plot improves from (1) to (3). As a general remark, we observed that both groups enjoyed the stories and did not have any difficulties in using the graphical interface. Analyzing the answers to the comprehension exercises, we have verified that the simplified story with animated illustrations is more comprehensible to deaf children as compared to stories (1) and (2). As future work, it could be interesting to add adjunct questions/aids to the story text and to evaluate their impact on deaf readers' comprehension skills.*

### 1. Introduction

As several studies report [1, 2, 3], most deaf children have specific literacy problems. With regard to the reading ability, they have problems at least at three levels of comprehension: lexical, morphological and inferential. At lexical level, they generally have a vocabulary limited to a few words and they tend to connect the meaning to the context, having difficulties in generalizing it [4]. They often fail in detecting the meaning of idiomatic expressions, metaphors and allegories [5]. To understand the meaning of an unknown word, intuitiveness generally helps to deduce its meaning from the context, resorting to personal experience. Unfortunately, even if they share the same experience as hearing people, deaf children cannot rely on comparable word knowledge. Literacy difficulties in deaf children are partly attributable to the hearing loss that prevents them from being precociously exposed to oral language, so that they cannot acquire verbal language through a natural process.<sup>1</sup> However, this condition is also due to the type of educational intervention they are faced with, which accustoms them to decoding single words and isolated sentences, rather than entire texts, thus making it difficult to manage complex texts as a whole and to develop the capacity to infer

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<sup>1</sup> The small percent of deaf children (around 10% of the total) who are born from deaf parents do experiment a natural exposure to the language through sign language. However, it is still a source of debate whether sign language knowledge helps children to acquire the verbal language too [6].

information from the text itself [7, 8, 9, 10]. Facing the fact that "being able to read is more important than ever" as "it is essential for achieving in school, being an informed citizen, succeeding in one's career, and experiencing personal fulfilment" [2], we have developed a software literacy tool running on the web, called LODE [11], in order to support Italian deaf children in improving their reading comprehension skills in Italian. The child using LODE will read an entire story and then do a series of comprehension exercises which should help him/her to reason on the read text in its totality. In the present contribution, we describe the steps we undertook to select and re-arrange the stories to be published in LODE and how we presented them on the basis of our target group's needs. Moreover, we discuss the results of an evaluation conducted with Italian deaf children aged 8 to 14 which tend to confirm the positive value of the project.

## **2. E-Stories for Deaf Children**

Deaf children are traditionally recognized as visual learners. Information technology (IT) techniques are a great resource for those who work with them: characteristics such as high memory capacity, visualization abilities, hyperlink- as well as multimedia and sophisticated artificial intelligence techniques can be exploited to build educational tools able to meet their specific needs in an effective way. Moreover, publishing the tools on the web allows to reach the biggest audience as possible.

### **2.1 The LODE's Stories**

There are two main aspects to be considered when looking for stories to be read by deaf children. First of all, they should attract children's attention to help them maintain their concentration on what they are reading. Deaf children are generally untrained readers and get bored quickly, therefore the text's "appeal" becomes vital to keep their attention high. Secondly, stories should be suitable for the children's literacy levels. Indeed, a too simple story may bore them, whereas a too difficult one may be frustrating. Both aspects relate to the children's age and their literacy level which do not correlate linearly. In fact, it is not infrequent that a deaf pre-adolescent is less literate than a younger child. With these purposes in mind, we searched the web looking for Creative common licensed texts, so as to avoid copyright problems. We then divided the stories we collected this way into two sets: one for younger children (8 to 10/11 year old) and one for older ones (11 to 13/14). For the younger readers we selected fairy tales whose protagonists are animals, whereas for the older ones we selected stories based on human characters. This last choice should exert a greater appeal to the older target group as the chance to identify with the stories' protagonists becomes greater.

Considering the many difficulties deaf children have in understanding texts (see Introduction), we decided to act on the story texts, simplifying all of them. We therefore reduced the number of subordinate clauses, of pronouns and clitics and substituted with synonyms or paraphrases those words that are not included in the "Lessico elementare", i.e. the frequency lexicon collecting the most common Italian words known to primary school pupils [12].

As some studies have pointed out [3, 13], pictures can efficaciously sustain text comprehension. For this reason we decided to add static and animated drawings to some stories with the double aim to render them even more attractive and also to add visual references to the texts which could "reinforce" the narration of the events (cfr. Figure 1: when the child opens the page, he/she sees the background image. Moving around the mouse, the user activates an animation; when clicking on it, the story text appears. Words with the yellow background are "active" words, i.e. they are linked to a dictionary proposing a textual definition, an example of use, an image and a video with the translation in Italian sign language (LIS)).

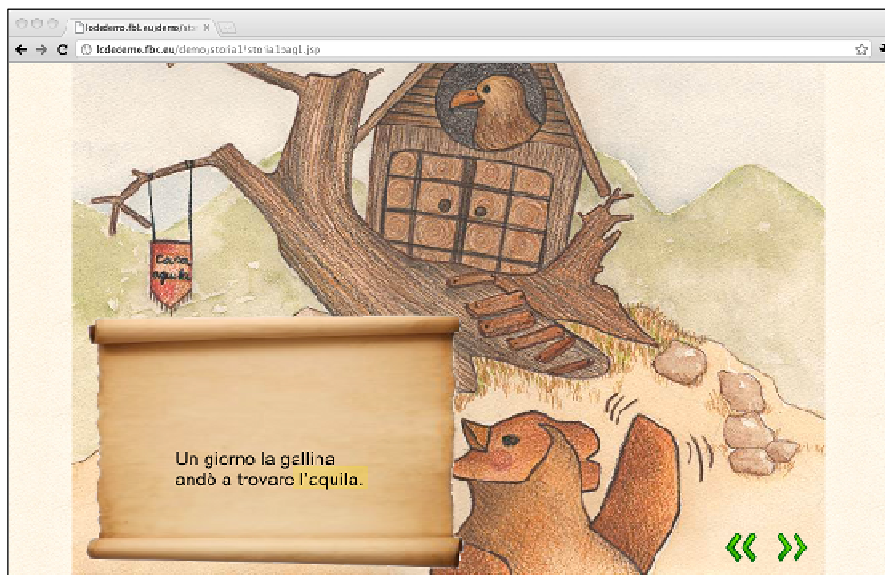


Figure 1. The simplified illustrated story: an example of an animated drawing.

### 3. Stories' Evaluation

To check if the LODE's stories are effectively more comprehensible to deaf children as compared to unsimplified texts, we performed a test involving eighteen Italian deaf children, ten aged 8 to 11 (in the following named yD) and eight aged 12 to 14 (oD), and twelve Italian hearing children, eight aged 8 to 11 (yH) and four aged 11 to 14 (oH), as a control group. The aim of the test was to verify if the simplification operations we conducted on the stories have rendered the story texts easier to read and more understandable for our target group. Moreover, we also aimed to test the effectiveness of using static and animated drawings to improve the readability of the simplified stories.

We provided two sets of three stories each: one for younger and one for older children. Each child read three stories out of his/her set in the following progression: a story in its original version (with a readability index<sup>2</sup> of 55 and 52), a simplified story as explained above (G.i. 64/58), and a simplified story illustrated with drawings and definitions (G.i. 72/60). Unfortunately, as we had to test all the children in one unique session, it was impossible to use the same story in the three different versions, therefore we employed three different stories, with similar characteristics, each in one of the forms described. After reading a story, the child answered the eleven questions foreseen for the comprehension exercises.

We found a significant difference among the responses to the sets of exercises related to the three stories in the yD group ( $F(330, 2) = 6.740$ ;  $p < .001$ ), but not in the oD group ( $F(264, 2) = 2.143$ ;  $p = .119$ ). In both cases there is an improvement of the correct answer mean from the original story (yD = 0.79; oD = 0.57) to the simplified illustrated version (yD = 0.88; oD = 0.70). Nevertheless, in the oD group the difference between the mean of correct answers given to the original story and the one relative to the simplified story is almost inexistent (0.57 versus 0.58). Moreover, in the yD group the mean of correct answers to the simplified story without images is lower (0.68) than the one achieved in the exercises to the other two story types. The main results are confirmed by the regression analysis which underlines that there is a significant difference among the three stories (i.e. the instrument fits

<sup>2</sup> We employed the Gulpease index (G.i.), a readability index implemented for Italian language. The two scales for primary and first secondary classes go from 55 (very difficult) to 95 points (very easy) and from 35 (very difficult) to 80 (very easy).

the purpose) and that the third one always appears to be the most comprehensible for deaf children. Not surprisingly, the two hearing groups always performed better than the deaf ones, but the difference in terms of correct answer mean is bigger among the older children (0.295 versus 0.084).

The analysis show that the stories meant for the older children do follow the pattern we had intended (from the original, more difficult story to the simplified-illustrated, easier one) and that the slightly - though non significantly- better performance of the hearing children does not depend on the type of stories at all. As regarding the test's goals, we have verified that the simplified story with drawings (and definitions) is the most comprehensible for both yD and oD groups. Given these results, we can therefore state that visual aids and text simplification do help children to understand a story more easily but, unfortunately, we cannot draw any firm conclusions about the simplification impact for the first, younger group, though the comparison with the control group's results do speak in favor of text simplification. Clearly enough, lexical and syntactic simplification alone is not sufficient to guarantee for the readability of a text by a deaf readership. The story's structure itself (event sequence, length etc.) has to be carefully designed in order to avoid confusion and boredom in the deaf reader, especially in the absence of drawings which help contextualize the events and information read.

#### 4. Conclusions

Providing suitable stories for deaf children is not a simple task. The parameters and the factors to be managed and kept under control are diverse and numerous and reside in the target group's specifics and needs, but also in the stories themselves – i.e. plot, climax, etc. – and in the (multi)media formats used to present them. Nonetheless, we have shown that though it might be challenging, it is possible to offer deaf children captivating stories they can easily understand and enjoy and which could improve their motivation to read. Reading for pleasure will open up new worlds for them and help them develop better literacy skills. As future work it could be interesting to add adjunct questions/aids to the story text and to evaluate their impact on deaf readers' comprehension skills [14, 15].

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