Evaluation of an Intelligent E-Tool for Deaf Children

[Extended Abstract] *

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ABSTRACT

LODE is a web tool for deaf children, which aims at stimulating global reasoning on written e-stories. This paper reports on an initial prototype application of LODE. First, we motivate the need of an e-tool such as LODE for deaf children, then we report on the assessment of the prototype with expert users and two deaf children, laying the groundwork for the final evaluation and development of LODE.

Categories and Subject Descriptors

K.3 [**Computers and education**]: Miscellaneous; K.4.2 [**Social Issues**]: [assistive technologies for persons with disabilities,handicapped persons/special needs]; I.2.m [**Artificial Intelligence**]: Miscellaneous

Keywords

Constraint programming, temporal reasoning, software evaluation

1. INTRODUCTION

Proficient literacy is essential for everyone; it ensures a continuous process of personal maturation and a positive social integration. Deaf children encounter several difficulties in learning to read and write with proficiency; they tend to reason on isolated concepts and not relate distant concepts in written texts [1].

Our LOgic-based e-tool for DEaf children (LODE) aims at stimulating children to *globally* reason on a written story by relating distant episodes — a step which is necessary for fully comprehending the story and its morale. This is done through apt exercises/games, developed with the assistance of experts in deaf studies. In its current form, LODE stimulates deaf children to reason on the temporal dimension of children's stories, written in verbal Italian. The technological core of LODE is composed of a constraint-based automated reasoner; the reasoner can be employed both for creating some of the LODE games automatically, and for generating individual feedback from the game solutions proposed by the LODE user. Automated reasoning has been used in intelligent tutoring systems before, see for instance [6]; but the LODE's breakthrough is to apply automated reasoning techniques, in particular constraint-based reasoning, to an e-learning tool for children, in particular deaf children, which opens up new possibilities as well as challenges; see [4].

This paper describes the educational goal of LODE and reports on the ongoing assessment of the initial prototype of LODE; a demonstrator of the tool is available online [3].

2. EDUCATIONAL AIM

Temporal dimension is a concept that children learn indirectly through narration [8]; this may explain why it tends to be a difficult concept for deaf children, who are not exposed to oral narration as hearing children are [1]. Children learn the *after* operator at around the age of four. They learn the *before* operator at around the age of five to seven. They learn the *while* operator last. Although children easily learn the *after* operator, they need more time for mastering the other operators. Telling stories to children is a way to help them learn operators that organise time, and enhance children's ability of comprehending written texts and writing narratives [2]. This is why we decided to design LODE around famous children's stories, stressing the temporal aspects of the stories.

LODE presents a list of e-stories the child can choose among. They are simplified versions of traditional children stories, such as *The Ugly Duckling*, so that the language is more suitable to an eight-year old deaf child; they are also enriched with explicit temporal relations so as to concentrate the attention of the child on **global temporal reasoning**.

The child has to choose a story from the list in order to begin his/her game session. The chosen story is presented, split across different pages; there is one sentence with an explanatory image in each page. After reading the story, the child can start a game session for **globally reasoning on the story's temporal dimension**. Uncommon words that may be difficult for deaf children are explained in a dictionary. In the remainder of this section, we only ouline two examples of temporal reasoning games of LODE tested

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so far; for more, please, refer to [4].

In **comprehension games**, the child is presented with temporal relations connecting events of the story (the relations may be implicit in it); the child is asked to judge which relations are consistent with the text he/she has already read. The possible relations can be constructed with the assistance of the constraint reasoner that can determine which temporal relations are consistent with the story.

Children can also tackle more challenging exercises, called **production games**, in which they have to produce besides comprehending parts of a story. For instance, in the so-called P2 games, children are shown scattered sentence units extracted from a story they have already read; then they should compose a sentence with these units, forming a temporal relation consistent with the story and which may be implicit in the story. Suppose that the available sentence units are: before, while, after, the big eggshell cracks, the small eggshells crack. Two are the possible correct sentences the child can compose, consistent with the story. One is: the small eggshells crack before the big eggshell cracks. The other sentence is: the big eggshell cracks after the small eggshells crack. If the child composes a wrong sentence, LODE will suggest how to correct the sentence with the help of the constraint reasoner. In the P3 exercises, the children can also invent a novel e-story by temporally ordering events proposed by LODE, to the children's liking. Anytime, the children can check whether their story is consistent, e.g., it is not the case that an event is simultaneously before and during another; they can also ask for the assistance of LODE, or better, of the constraint reasoner of LODE in setting new temporal relations between events, consistent with their own story.

3. ASSESSMENT

After implementing a first prototype of LODE, we assessed it with its intended users. First, we heuristically tested it with adult experts, namely: several Italian sign language interpreters and teachers of deaf children, a logopaedist, a linguist expert of deaf studies, two cognitive psychologists expert of deaf studies for assessing the educational goal of LODE; five software engineers, one specialised in web usability, another specialised in assistive technology, as well as an emotional design expert for testing the usability of the design of our prototype. We also tested it with two deaf children assisted by their parents and teacher. Children were observed while playing with LODE; their actions were recorded on a video and stored in a log file. Information on the children's level of deafness, literacy and acquaintance with internet browsing were gathered prior to the test session by interviewing their parents. With the assistance of their teacher, children filled in a questionnaire concerning LODE, in order to know whether they liked the tool, its games and the story they had read.

The adult evaluators approved our e-tool and the implemented educational games. In particular, they agreed on the importance of stimulating deaf children to reason on time and not on isolated episodes, but on global narratives. The two children testing LODE appreciated it: the older child (thirteen years old) read quickly the story and easily tackled the games. She did not have problems with the navigation, whereas the other one (eight years old) was not able to navigate without the help of her teacher, mainly due to the kid's poor reading capability.

The first evaluation did not give us statistically consistent information on the usability of LODE; obviously, we need to evaluate LODE with more deaf children, its end-users. However, due to the difficulties in involving deaf children and their parents in such activities, our preliminary assessment already suggested that we are on a good track. It ensured us on the need of an e-tool such as LODE for global reasoning on e-stories, in agreement with the literature findings examined in [5]. Moreover, the evaluation gave us indications on what to improve in terms of navigability in the games, and the design interface of LODE in general. For instance, of the ten rules for user interface design prescribed by [7], the first prototype of LODE did not feature the visibility of the system status and recognition rather then recall rules. Future versions of LODE will also feature a translation of the dictionary words into Italian Sign Language (*Lingua Italiana dei Segni*, LIS) in order to facilitate their comprehension to LIS speakers.

The second evaluation phase is in progress; it aims at assessing the efficacy of LODE in stimulating children to globally reason on e-stories. It is conducted as a controlled experiment; deaf and hearing children are involved in the test so as to minimise the risk of misinterpreting possible deficiencies of the interface design. Currently, LODE is under evaluation with fourteen hearing children, successively LODE is going to be tested with circa nine deaf children, all aged eight to ten. The third evaluation phase, which is planned as a controlled experiment in 2009, aims at delivering the final LODE prototype which fully integrates all the modules of LODE.

4. REFERENCES

[1] B. Arfé and P. Boscolo. Causal Coherence in Deaf and Hearing Students' Written Narratives. *Discourse Processes*, 42(3):271–300, 2006.

[2] P. Calliari and M. Degasperi, editors. *I Bambini Pensano con le Storie*. IPRASE del Trentino, Provincia Autonoma di Trento, 2007.

[3] R. Gennari and O. Mich. Lode demo. Available at `http://www.inf.unibz.it/lode`. Last visit: Jun 2008.

[4] R. Gennari and O. Mich. Constraint-based Reasoning for E-learning with LODE. In C. Bessiere, editor, *Proc. of the 13th International Conference on Principles and Practice of Constraint Programming (CP2007)*, LNAI/LNCS. Springer, 2007.

[5] R. Gennari and O. Mich. Global Temporal Reasoning on Stories with LODE: a Logic-based E-tool for Deaf Children. Technical report, KRDB Research Centre, KRDB08-4, 2008.

[6] Icicle. Available at `http://www.eecis.udel.edu/research/icicle/`. Last visit: Jun 2008.

[7] J. Nielsen. Heuristic Evaluation. Available at `http://www.useit.com/papers/heuristic`. Last visit: Jun 2008.

[8] R. Simone. *La Terza Fase. Forme del Sapere che Stiamo Perdendo*. Laterza, Bari, 2000.