

# Application of qualitative reasoning models in the scientific education of deaf students

Paulo Salles<sup>a</sup>, Gisele M. Feltrini<sup>b</sup>, Isabella G. de Sá<sup>a</sup>,

Mônica M.P. Resende<sup>b</sup> and Heloisa Lima-Salles<sup>c</sup>

<sup>a</sup> Institute of Biological Sciences ([psalles@unb.br](mailto:psalles@unb.br); [isabellagontijo@gmail.com](mailto:isabellagontijo@gmail.com))

<sup>b</sup> Graduate program in Science Teaching ([gisele\\_morisson@yahoo.com.br](mailto:gisele_morisson@yahoo.com.br); [monicamresende@terra.com.br](mailto:monicamresende@terra.com.br))

<sup>c</sup> Department of Linguistics, Portuguese and Classical Languages ([hsalles@unb.br](mailto:hsalles@unb.br))

University of Brasilia, Brazil

## Abstract

Regarding the education of deaf students (in Brazil), three conditions have to be met in order to bring qualitative reasoning (QR) models into the classroom: (a) a bilingual education should be provided, the Brazilian Sign Language (LIBRAS) being the first and Portuguese the second language; (b) in the absence of scientific vocabulary in LIBRAS, it has to be created; (c) given the aural impairment, which is cognitively compensated through an over-developed visual ability, a visually oriented pedagogy is needed. This paper describes how qualitative reasoning may provide an adequate scenario to create a vocabulary in sign language for representing scientific concepts while offering support for the integration of visually-oriented models and simulations, and written Portuguese in educational activities.

**Key words:** qualitative models, deaf, science education

## 1. Introduction

The Brazilian educational system is nowadays faced with the legal determination of promoting the education of deaf students along with hearing students in the so-called inclusive classrooms. In this context, it is important to understand the requirements for a successful inclusion of the deaf. Previous work [4; 6] has shown that QR models [7] are powerful tools for the education of deaf students, as they have interesting features for accomplishing this task: they articulate knowledge about different physical and social systems in conceptual models, presented with a graphical interface. A concise vocabulary is used to describe the phenomena represented in the models, and a restrict set of modeling primitives is enough to represent a wide class of scientific concepts. Finally, explicit

representation of causal relations makes it possible to ground predictions and explanations about the system behavior. In this context, the present work seeks to answer the following question: *What are the requirements to bring qualitative models into the classroom as useful tools for science education of deaf students?*

## 2. Sign language representation of QR models

Education is a well established area of application for QR models (Bredeweg and Forbus, 2003). This work explores these models as a tool for acquiring scientific concepts, improvement of linguistic skills and of inferential reasoning, already worked out with deaf students (Lima-Salles *et al.*, 2004; Salles *et al.*, 2005). Two qualitative models were used, 'tree and shade', already used and validated in (Lima-Salles *et al.*, 2004), and 'global warming', created to be the testbed for this study. The models were built in the QR engine Garp3 (Bredeweg *et al.*, 2006), following the Qualitative Process Theory (Forbus, 1984).

The causality chain shown in Figure 1 reads as follows. With investments, industry produces residues, including greenhouse gases. Besides that, in order to develop agricultural activities, farmers remove natural forest and burn residues of biomass, also releasing greenhouse gases. Both processes positively influence the Gross Domestic Product (GDP), and pollutant concentration influences the Earth temperature. Above a certain threshold, a positive influence establishes



skills and of logical reasoning. The didactic material produced in the project may become the basis for the creation of a community of practice of deaf and hearing students that learn scientific concepts with the support of QR models and modern AI technologies (cf. www.dynalearn.eu).

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