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Visual representations of educational processes

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Abstract. As an editorial to this special issue, we pinpoint some ways on how visual representations of educational processes can help analyzing these processes, and in turn lead to designing of new tools informed by interdisciplinary research.

Keywords: Visualization, Simulation, Educational, Cognitive processes, Technology-Enhanced Learning

1. Introduction

Novel visual representations like networks, diagrams, timelines, etc., mainly computed by educational data mining techniques, shed light on novel ways to interactively display and, thus, analyse processes occurring in education (e.g., Castro et al., 2007; Tergan & Keller, 2005). These processes, occurring in either learning or instruction, are largely hidden and tools to allow both their representation and their analysis may be useful. Interdisciplinary research (computer science, cognitive science, educational research) aiming at designing and building such tools is currently growing.

This need comes from two different causes. First, most of high-level professional abilities (like in surgery or aircraft piloting) occur in dynamic environments (e.g., Gillie & Berry, 1994). They are very difficult to acquire and master, and every incidental event may lead to accidents, so students are better and more securely trained in simulators. Second, even in more static environments (like writing a text in a word processor), complex knowledge is often difficult to be represented because it is mainly tacit, causing learners to manage semiotic (Duval, 2006) and psychological issues (Hayes, 2006).

In both cases, the two-directional flow of information between the training device and the users is worth designing and analysing with the help of specific tools. Besides these research purposes, such representations can

be considered as pieces of feedback that interact with trainers' or trainees' knowledge and can foster self-regulative processes.

The papers of this issue highlight how learners and trainers have to cope with the complex situations in which they are immersed: either in reading textbooks (Galilée, Dépret, & de Vries, 2015), in writing argumentations (Benetos & Bétrancourt, 2015), in assessing chat discussions (Trausan-Matu & Dascalu, 2015), and eventually in piloting aircrafts or performing surgical interventions (Toussaint, Luengo, & Jambon, 2015).

2. Overview of the contributions

Galilée, Dépret, and de Vries (2015) describe in their paper the Math Texbook Time Machine (MTTM), a web-based tool that displays the same maths lesson in 6 different textbooks formats from different decades (1960's to 2010's), so in different visualizations to be compared to each other. This device aims at introducing teachers, who likely design their own lessons, with possible pupils' confusions induced by textbook design. More generally, this software may promote teachers' historical awareness on these aspects, through teacher professional development sessions. As Galilée et al. point out, learners are usually provided with a large range of external representations that can confuse them. A careful semiotic analysis of these representations (in their case, embedded in a textbook) raises very important considerations about the importance of their domain-specificity, and about their transparency for teachers who often do not foresee learners' interpretation issues.

The contribution by Benetos and Bétrancourt (2015) introduces to C-SAW (Computer Supported Argumentative Writer), an environment that promotes reflection and self-assessment during writing of secondary and university students. Each piece of argument can be manually labelled and organized, using a set of pre-defined prompts and logical connectives. On-line traces of writing are gathered in the system and visually represented. The whole writing session can be represented afterwards as a concept map, providing a big picture of the writer's patterns of use. The study presents a usability test involving 8 participants, and the transition probabilities for some of their actions are analysed. Benetos and Bétrancourt show how visually representing argumentation processes and proposing specific aids

and prompts make user self-regulate their writing process. In turn, both trainers and trainees can act upon this process in a reflective manner.

The paper by Trausan-Matu and Dascalu (2015) first reviews theoretical and technical paths for visually representing university students' voices in a chat. The authors propose, on top of Bertin's (1967) semiotic classification, a way to describe the different graphical chat visualizations that exist in the literature. The Bakhtinian theory, through the concepts of 'voice' and 'dialogues', is then interestingly applied for analysing the interplay of participants' utterances in chats. Teachers and learners can take great advantage of visualising such information. Both content (voices or thematic information), relationships between utterances, as well as more aggregated information, like knowledge-building or participation, enable them to better understand the content at stake in the discussion, and to undertake self-regulation processes.

Toussaint, Luengo and Jambon's (2015) study presents a method to capture and model multimodal interactions in an orthopaedic surgery simulator, based on an Intelligent Tutoring System. Knowledge involved in using such a simulator has multiple sources (2D images, 3D objects) and is very complex. This study aims first at gathering trainees' traces of on-line perception (through an eye-tracking device) and action, then at analysing them with data mining techniques. The surgical model is also applied to another context: aircraft piloting. They show that the flow of information (sequences of errors and successes) in this new environment can also be modelled by their system. The results, as other researchers like Quesada et al. (2002) also showed, raise the question of the extent to which this device can be generic and model a large range of actions in dynamic environments.

3. Conclusion

All in all, the "Understanding is Seeing" metaphor (Lakoff & Johnson, 1999) fully applies it this series of articles and can adequately be reversed in "Seeing is Understanding". This issue introduces tools to develop inter-disciplinary research on how categories of signs co-occur in textbooks (Galilée et al.), how arguments connect to each other to make argumentations (Benetos & Bétrancourt), to what extent utterances can impact to each other in chat discussions (Trausan-Matu & Dascalu), and

eventually how eye-tracking devices can help researchers model decision-making processes in dynamic environments (Toussaint et al.).

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